DEDICATED TO

C. H. S.

AS A SOUVENIR

OF

MUCH HARD WORK AND MANY WANDERINGS

TOGETHER IN THE TROPICS.

Photo by] *[C. W. Barrett.*

THE FIRST TAPPING OF RUBBER IN PORTUGUESE EAST AFRICA.

A Castilloa Sp. Tree, about 8 years old, on an estate at Marromeu (Luabo Co.), on the south bank of the Zambesi.

NOTES ON

SOIL AND PLANT SANITATION

ON CACAO AND RUBBER ESTATES

BY HAROLD HAMEL SMITH

Editor of "Tropical Life"; Author of "Cacao in the West Indies," "Future of Cacao Planting," "Aigrettes and Birdskins," &c., &c.; Member of the West India Committee; Cor. Mem. Soc. d'Etudes d'Agric. Tropicale, Brussels; Cor. Mem. Soc. Int. d'Agronomie Coloniale, Paris.

WITH AN INTRODUCTION BY

PROFESSOR WYNDHAM DUNSTAN,

M.A., LL.D., F.R.S., F.C.S., ETC.

Director of the Imperial Institute; President of the International Association of Tropical Agriculture and Colonial Development, &c., &c.

CONTAINING 108 ILLUSTRATIONS

LONDON
"TROPICAL LIFE" PUBLISHING DEPT.
JOHN BALE, SONS & DANIELSSON, LTD.
OXFORD HOUSE
83-91, GREAT TITCHFIELD STREET, OXFORD STREET, W.

—

1911

THE FOLLOWING AUTHORITIES HAVE KINDLY CONTRIBUTED

TO THE BOOK:

RUDOLPH ANSTEAD, S. India.
O. W. BARRETT, Philippine Isles.
HERBERT Y. BULT, F.C.S., London.
STANLEY R. BULT, London.
A. E. CASSE, Hayti.
WM. CRADWICK, Jamaica.
F. J. DUNLEAVY, Sorata, Bolivia.
FRANK EVANS, Trinidad and Hawaii.
WM. FAWCETT, B.Sc., F.L.S., Ex-Director of Agriculture, Jamaica.
W. J. GALLAGHER, M.A., Kuala Lumpur.
PROF. H. C. HENDRICKSEN, Cuba.
J. HINCHLEY HART, F.L.S., &c., Trinidad, W.I.
J. L. HERMESSEN, Mexico.
W. H. JOHNSON, F.L.S., Director at the Gold Coast, then Mozambique, now of S. Nigeria.
W. M. MALINS-SMITH, Grenada, W.I.
T. PETCH, B.A., B.Sc., Ceylon.
F. A. STOCKDALE, B.A., F.L.S., British Guiana.

&c., &c., &c.

INTRODUCTION.

Mr. Hamel Smith has asked me to write a few words of introduction to his Notes on Soil and Plant Sanitation, and I gladly comply with his request, especially as he desires that I should express approval of the important principle he advocates of close attention to plant hygiene and remedial treatment of disease in all tropical plantations.

Questions of this kind are now beginning to be recognized by planters as among the most important in connection with the successful management of estates, and consequently not only have the subjects of plant sanitation and plant diseases recently attracted increased attention from scientific workers, but planters are beginning to find it advantageous to engage the services of specialists on these subjects to conduct experiments and advise them in their work.

Entomology and plant mycology are now playing a very leading part in relation to im-

proved planting in the Tropics, and valuable results have been obtained, especially in Ceylon and Malaya.

The misfortune is that in many cases the recognition of the importance of these subjects has been too long delayed and much damage has been done which now can only be repaired at great expense. At the same time it must be emphasized that in all these subjects we have still much to learn, especially as to the practical steps which ought to be taken, and much difference of opinion and of practice exists at the present time. Mr. Hamel Smith's "Notes," embodying, as they do, besides his own opinions those of some of the best known authorities in the Tropics, ought to be of value in promoting the consideration and discussion of many important questions.

In speaking at the Royal Colonial Institute last year on a paper on planting in Ceylon, Malaya and Java, by Mr. John Ferguson, C.M.G., I drew attention to the necessity of some measures being taken to provide for the systematic training of those who enter the planting profession (see "United Empire," 1911). It is high time that we recognized,

as France and Germany have already done, that it is not safe to depend upon the chance of acquisition of knowledge during the kind of apprenticeship into which young men now usually enter as the first step in the planter's career. Tropical agriculture is like several other professions, a branch of applied science, and it is imperative, if those who enter it are to be successful on modern lines, that they should in the first instance gain an acquaintance with the first principles of agriculture and the sciences on which it depends, instead of being left to "muddle through." For the majority of young Englishmen this preliminary knowledge is best acquired at the Agricultural Departments of one of the English Universities or at one or other of the excellent Agriculture Colleges which now exist in this country, Here they would acquire that fundamental knowledge of the principles of chemistry, especially in their relation to plant nutrition and metabolism and the composition of soils; of the principles of botany in relation to the habits and growth of plants and of the parasitic and fungoid diseases to which they are subject; of the principles of entomology in relation to the life-history of the

insects which attack plants and the means of dealing with them. At an Agricultural College these young men would also learn the essentials connected with the management of animals and the methods of keeping business-like records of crops and other details of the management of estates, and generally would be brought up in that agricultural "atmosphere" in which it is so important that they should become acclimatized at an early age.

After passing through this preliminary course a young man would be in the best position to commence his study of tropical agriculture, which whilst depending upon the application of the same sciences as he has already studied and presenting the same general features, has its own special facts and problems, which need study before the practical business of planting is actually begun. It is often contended that tropical agriculture is best studied by apprenticeship or pupilage on a tropical estate. I do not agree with this opinion even in the case of young men who bring to the task a general knowledge of agriculture acquired in this country. It is true that there are practical details connected with the successful manage-

ment of a tropical estate which are only to be learned on the estate, but there are many questions of a scientific character which cannot, as a rule, be so well acquired there and as to which, especially from the standpoint of the success of the estate itself, the newcomer should be fully informed when he arrives.

In Europe this position is now conceded, and few at the present time doubt the wisdom of preliminary scientific study and of the general principles of crop and estate management as an essential preliminary to taking up the profession of farming. It is no longer generally argued in this country, as it used to be, that the best introduction to the profession of farming is apprenticeship to a farmer or pupilage on a large estate, and the case is the same for tropical agriculture. On the occasion referred to I advocated the establishment in the Tropics of an Agricultural College of a kind which does not at present exist, so that when the young man already partially trained arrives in the Tropics he should be able to acquire in the best possible way some knowledge of the special features and problems of tropical agriculture at a College fully

equipped for the purpose, before taking up detailed work on a tropical estate.

The suggestion has been received with general favour, but opinions appear to differ as to the best site for the proposed College. This is a matter of secondary importance. I have suggested that, all things considered, Ceylon, with its excellent climate, its varied tropical crops, including rubber, cocoa, tropical foodstuffs, and tea, its large and well-managed plantations available for purposes of instruction, offers the best opportunities for the establishment of the College which is required. The general features and problems of tropical agriculture are one and the same in all tropical countries ; the detailed differences which exist must be subsequently learnt in the particular country, but I contend that a man who has properly studied rubber cultivation in Ceylon is well qualified to enter a rubber plantation in any other country, when he would soon learn the special peculiarities and the different details of management which may be involved, There are practical details which can only be acquired on an estate, and all that is to be attempted in a College is to

provide a knowledge of those general principles of planting which are common to all tropical estates. One of the most successful agricultural Colleges in England is in the South of England, where agriculture presents many differences from agriculture in the North and in the East of England, yet the roll of this College shows that its students afterwards take up practical farming in every part of the United Kingdom.

To the Editor of *Tropical Life* is due the proposal that this Agricultural College in the Tropics should be founded as the Tropical Memorial to King Edward VII. The proposal has much to recommend it, and only needs for its realization concerted action on the part of the Governments and planters in the British Tropics.

It is intended that an International Congress of Tropical Agriculture shall be held in London next year, and the subject of the proper training of tropical agriculturists is no doubt one which will prominently engage the attention of the Congress, when the steps to be taken can be fully considered and discussed.

The subject is one of importance, not only

to all those Companies which have estates in the Tropics, and to parents whose sons are to enter the planting profession, but also to the Governments of all our Tropical Colonies. In recent years Agricultural Departments have been founded and extended in all the Tropical Colonies, and it is essential that the officers appointed to them should be thoroughly trained men. The Colonial Office has already taken preliminary steps to secure that the officers appointed shall not be chosen haphazard, but shall produce evidence that they have received an appropriate training in general and tropical agriculture. As agricultural enterprise develops in our Colonies, a steady supply of well-trained men will be needed by Government in addition to those required for private enterprise, and it is obviously necessary that proper provision should be made for training the men who are to enter one of the most important professions with which the welfare of the whole Empire is so intimately associated.

WYNDHAM R. DUNSTAN.

Imperial Institute,
February, 1911.

PREFACE.

In offering the following notes to my readers I do not personally pretend to lay down any infallible rules to be followed, or to pose as a scientific expert in the matter of up-to-date planting. I have left that to others, who have been kind enough to supply the pages on the scientific treatment of the soil, trees, and crops. Even with their aid, I cannot pretend that I have included a tenth part of what one could and should say on the question of increasing yields, and preventing or curing diseases. It is now some time since I was on a cacao or rubber estate, and there is no gainsaying that more changes have taken place, more theories have been advanced, and far more scientific and general progress has been made, during the last five years than during the twenty-five or even the fifty years that preceded them. Lookers on, it is truly said, see most of the game, and so, although I have not had the great advantage that most

PROFESSOR WYNDHAM R. DUNSTAN, M.A., LL.D., F.R.S., Director of the Imperial Institute, London; President of the International Association of Tropical Agriculture, &c., &c.

of the readers of *Tropical Life* can claim, of visiting Malaya, or the Far East, Mexico, the West Indies or Brazil, since the beginning of this century, I have had the pleasure and profit of sitting in my office in London, during the last ten years, and receiving visits or letters from some five or six hundred practical planters, men of science, directors of agriculture, and others actually engaged in planting up and developing the Tropics. Their information I have made careful note of and compared, the one with the other, and now beg to offer to those, who are interested in such matters, a *résumé* of a small portion of the notes made, viz., those which I have jotted down since the beginning of 1910 only, together with reports from elsewhere confirming my views, and suggestions as to how to circumvent the trouble that I can only point out and warn you against. I do not go very far back because times change so quickly, that no one wants items of history in their handbooks, but have tried to include such scraps of information as will show which way the wind blows, so as to enable my readers, should they think it to their advantage to do

so, to follow the wind, or to turn it round and cause it to blow in a different direction; one which, after noting how others have prospered

PROFESSOR ED. DE WILDÉMAN.

Professor de Wildéman is the leading Belgian authority on tropical plant-nomenclature, and rendered yeoman service to tropical agriculture generally by undertaking the arduous post of Secretary of the International Congress of Tropical Agriculturists, held in Brussels, May. 1910.

by its former course, they believe will be better for them individually. I do not pretend to tell anyone what is best for them; they on

the spot are far better able to judge this. I only show how things are tending, and offer suggestions as to how the present ideas can be further developed and taken advantage of at the various producing centres.

The first portion of the following pages is based upon the paper that I submitted to the International Congress on Tropical Agriculture, held in Brussels in May, 1910, which I had the pleasure of attending. The paper never came on for reading, but the interest shown in its contents by the delegates present, with whom I discussed the various points at great length, was far beyond anything I anticipated, and showed how seriously the question of pest-extermination and pest-prevention on international lines is regarded on all sides. Those who do not pay careful attention to these matters are either too indolent or too selfish to do so, and such people, being a menace not only to their neighbours, but to the producing centres at large, should be watched and warned. If, after persuasion, they will not mend their ways, then I would suggest that force be brought to bear upon them until they do so. Disease on an estate may cause

trouble to the whole producing world, as the man who is careless of himself and his neighbours would think nothing, should he receive orders for seeds, plants, or cuttings, of sending these to all parts of the world, to spread trouble and disease wherever they go. On account of this, many centres at present free of disease, and therefore anxious to keep the trouble out, are kept back because they are afraid to import seeds and plants of improved sorts, as, with all the care and goodwill of the exporter, and although his individual estate may be the perfection of healthiness, &c., no one can guarantee that disease-germs from a careless neighbour may not have contaminated his plants as well. Thus this question of estate sanitation is truly an international as well as a local matter, and its being so is why I chose it as the subject of my paper for the International Congress.

I maintain that when opening up fresh tropical forest-lands, or laying down new estates, the authorities should take quite as stringent precautions to safeguard the health of the trees, plants, &c., as they are expected to do (and will do if they are wise and wish

to attract the best men and adequate capital to their country) when building a new city.

Trees, like human beings, become, under civilized conditions, more delicate and liable to disease, or else it is that the scientific man and the doctors enable them to live under conditions which in the natural state the struggle for existence would have rendered impossible. In any case, their average vitality is below that of the less cultivated kinds. This has its disadvantages as well as its advantages. The advantages are that the world, or the estate, has a larger number of occupants than would have been possible fifty or a hundred years ago, and these occupants on the whole pay their way and leave a margin of profit, and so are encouraged to still further multiply. But the constitutions of these individuals, taken on the average, are less robust than the wild or less cultured kind, and more liable to degenerate and contract disease, which once contracted is liable, if not attended to, to spread around in the most alarming fashion. If a cacao or rubber tree in its natural habitat becomes diseased, probably there is not another near enough to contract or to pass it on to

a third one, but in a closely planted cultivated estate, the contagion can spread like the plague is doing in Manchuria.

In regard to this, may it not be worth while for the Government or planters of Malaya to send a mycologist to Brazil to look for the same insects in the Amazon Basin that are troubling Hevea plantations in the East, and if found to exist, to try and discover Nature's remedy for preventing those insects, &c., from attacking the trees and damaging them seriously. Although one seldom hears of diseases on the Amazon, or of insects destroying the trees out there, as they do on the estates, the pests may still be present; and that their ravages never materialize beyond the initial stage may be due to the presence of something else that preys upon them in turn. It cannot be light and air, although these are undoubtedly good for keeping pests away on cultivated lands. I would not consider any attempt to study the life-history of the insects that are attacking the trees in the East complete without a visit to the Amazon rubber-country, to find out if the same insects exist there. From my planting

experience and what I have noticed of the diseases, their liability to come and go, and

LIEUT.-COL. D. PRAIN, I.M.S., C.I.E., F.R.S., M.A., &c.
Director Royal Botanic Gardens, Kew.

possible antidotes or remedies, there generally seems to exist in the neighbourhood of the

trouble something in Nature to counteract the destructive work of smaller, or other insects, &c., which prey upon economic plants and trees. On a cultivated estate, and in cultivated centres, where there are thousands and millions of trees of the same kind, and all are produced under similar conditions, the disease, once it appears (and up to now it always has appeared sooner or later), is certain to run riot, unless stopped by a belt of another kind of tree. Just the same as the prairie farmer on ahead burnt a patch of grass to stop the prairie fire, or as, in the great fire of London, gaps were made by blowing up houses not yet burning to stop the main fire, so only can a rampant disease be stayed on an estate, by forest, or other belts of trees less liable to the diseases of the main crop. This I have touched upon in my notes, as well as another point of the same question, viz., the chronic weakening of the plantation rubber and cacao trees by excessive cropping. Not only does "culture" produce a less sturdy and vigorous class of tree, compared to its forest-grown cousin, but also the cultivated tree is forced and called upon to give crops without

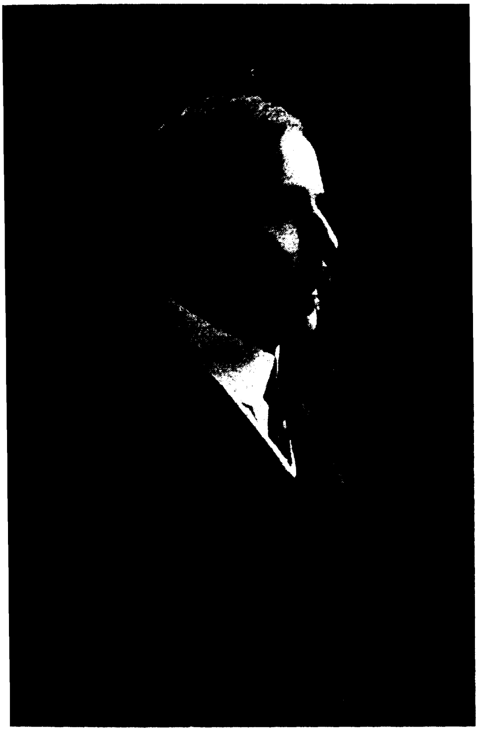
a break, in a way that the forest tree is never expected to do. Were it possible to tap the strongest trees in the Amazona valley every day, and all days, as is done on a dividend-earning rubber estate in the East, the Brazilian tree would then, I am sure, be far more liable to disease and decay than is now the case. It is of the utmost importance, then, if rubber, cacao, or other estates are to be laid down successfully in the East on the enormous scale it is proposed to do, *on paper*, that both the independent authorities at the head of affairs, as well as the planters themselves, insist that one and all of the estate owners shall take every reasonable precaution to keep their trees healthy, and their lands well cultivated and adequately supplied with plant food, so that the trees planted on them may be adequately nourished, and be less liable to disease. If this is not done, if one or two black sheep are allowed to run loose, the whole district may, and probably will, become affected, and the steady flow of capital now setting in towards developing the Tropics (and through that, be it remembered, benefiting the general import and export trade of temperate countries as well) may receive a

shock and a set-back that it would take years to recover, and all perhaps through the carelessness or indifference of one or two men.

The congested state of the labour market, and the tendency of the over-production of manufactured goods in Europe or America, owing to lack of orders from abroad, render it of the greatest national, and international, importance, that nothing, possible to avoid, be allowed to discourage the splendid openings for fresh channels of trade that a judicious and profitable development of the Tropics offers to us. For this reason alone, it is the duty of each one to see that every precaution is taken to prevent outbreak of diseases on estates; or should they appear, to assist in stamping them out as quickly and thoroughly as possible. It is with the object of assisting in this, in a small way, that I have decided to publish these notes in book form, in the hope that those who have not yet realized the importance of the subject in the past will be led to do so in the future.

With the present march of events and the direction in which we seem to be moving as regards tropical agriculture generally, the ideas that I have formulated have caused me to

feel that sooner or later legislation along the following lines will have to be adopted:—



SIR DANIEL MORRIS, K.C.M.G., D.Sc., &c.
Ex-Imperial Commissioner of Agriculture, West Indies.

(1) Since it has been seen that economic trees and plants, such as cacao, rubber, coco-

nuts, cotton, &c., are very liable to attacks of contagious diseases, insects and other pests, it may be, and probably is, advisable for the authorities to take steps, both locally and internationally, to protect the trees, as far as possible, the same as is done in the case of human beings.

(2) That if such inter-colonial or international action be taken, a planter or manager, who through carelessness, ignorance, or indifference, allows his trees to contract disease, must be warned, and precautions taken by the authorities, as in the case of human beings or animals, to localize the trouble and prevent its spreading to the more careful or fortunate estates in the neighbourhood, and even throughout the entire centre.

(3) This might at times necessitate the sacrifice of many trees, or cause a substantial reduction of the crop on a particular estate or estates, for a season or two, in the case of heavy cutting back. Should it be proved that the trouble was altogether unavoidable to the owner of the estate, and not brought about by his fault, then some compensation might be given to the planter should the loss

be sustained for the public good. Great caution, however, would have to be exercised on this point, for whilst one wants to be fair to the careful man, it may be found that some of the planters do not deserve any compensation (rather, perhaps, to be fined for the risks they cause their neighbours to run), and might even let the estate go back, as being an easy way to raise money.

(4) Those, therefore, who have disease or insect pests on their estates that are likely to spread elsewhere should be encouraged, and even, if necessary, be forced to spray and prune back the trees, to try and remedy the trouble; and to cultivate, drain, and manure, &c., the land, in order to try and prevent a recurrence of the disease, or to take such other steps to be generally agreed upon, as being likely to keep the disease in check, if not actually to cure it.

(5) In opening up new areas on a large scale, wide forest belts should be left at stated intervals, in order to restrict the area of disease should it break out, as it seems doubtful whether there are any economic plants yielding crops which are altogether reliable

for keeping disease out, when planted as intermediary belts between cacao and rubber. One or other disease or pest seems to be common to any suitable second crop. Experiments should be made to prove this, because, of course, forest belts take up a good deal of room, and harbour squirrels, &c., and their space can otherwise be filled by crop-yielding trees with profit. I believe, on the whole, however, that indigenous forest belts would be a benefit if carefully watched and tended, to see that dead branches or trees are not left about to serve as a source of infection, by the cultivation of Thread Blights; possibly also die-back disease, due to *Lasiodiplodia theobromae*, as well as to many scale-insects, *e.g.*, *Lecanium viridi*, which can find shelter in forest belts, and thence spread to cultivated trees.

Attention has been called to the spread of pod-rot in cocoa in Jamaica, and the trouble may get so serious that the *Journal of the Jamaica Agricultural Society* considers that some legislation ought to be provided to prevent pods being thrown about cultivations or heaped up at the several places where dealers buy, dry, or cure their cacao. Not only do

these rotting pods lying about cultivations, and especially heaps of rotting pods, become breeding places for disease, but they are also wasteful, because the broken cacao pods form an excellent manure if buried with lime through the cultivations. Cacao pods should always be collected and buried, with a little lime on them, between the cocoa trees, when instead of forming breeding grounds for disease they form good feeding ground for the roots and help to increase the crops.

With regard to local regulations, Mr. Petch points out that a Pest Ordinance has been in force in Ceylon since 1907, by which owners can be compelled to treat diseases, and Mr. Anstead calls attention to the attempts being made in the same direction by Travancore, a Native State in Southern India, to deal with coco-nut diseases. Mr. Cradwick is in favour of Jamaica doing the same, whilst in the German Colonies, Mr. Moritz Schanz reports that the authorities there insist that every cotton planter, even if insect pests are not prevalent in his cotton fields, shall burn or otherwise destroy the stalks, leaves, &c., of the cotton plant, or the parts pruned off in

case of a perennial cotton. A fine not exceeding £50, or imprisonment, or both, will be imposed in case of neglecting to comply with these instructions. Other centres have similar local laws, but an international agreement should be arrived at as well.

With regard to legislation to enforce sanitation, it must be remembered that there are many considerations to be taken into account, such as the difficulty of identifying some diseases, &c., so that it is not always easy to arrange for such legislation at first, but, at the same time, Mr. O. W. Barrett tells me much has been done to restrict pests, as can be seen by the U.S.A. Regulations. The care taken in respect to the importation of plants in the West Indies (see Regulations published in the *West Indian Bulletin*, vol. x., No. 314) is another example. More, however, is required to be done on international lines.

This question of international compulsion or control, maintains Mr. Hinchley Hart, writing from Trinidad, where they have had plenty of experience, is a difficult one to get adopted. At the same time, he agrees that as regards the value of the hygienic or sanitary control

of estates, there can be no doubt that it is essential, not only for other estates, and the producing centre generally, but for the pockets of the individual owners as well. Should, however, international agreement be arrived at in connection with contagious (plant) diseases, the inspectors would have to possess special mycological knowledge, in fact, would have to be Quarantine Plant Doctors. At present the tendency seems to run in the direction of entrusting inspecting and fumigating work into the hands of a Customs officer *of low grade who, whilst doing his best,* certainly cannot be expected to have the necessary knowledge to carry out the responsible work of condemning or disinfecting valuable, if doubtful, imports.

In conclusion, I have to point out that the methods I was forced to adopt in order to get my suggestions and statements confirmed by leading experts at the producing centres, whilst adding greatly to the value of the book, have been, at the same time, the cause of its defects, viz., delay in getting out, and an apparent inconsistency in the spelling of such words as "fungous" and "*brasiliensis.*"

The book, in spite of these drawbacks, has greatly gained by the additions put in at the eleventh—I could well say at the twelfth—hour, and all will welcome their inclusion. At the back of the title-page I give the names of those who have so kindly helped me, and trust that no one has been forgotten. It only remains for me to thank Professor Wyndham Dunstan for his Introduction. His position as Director of the Imperial Institute, as President of the Association Internationale d'Agronomie Tropicale, and as one of our leading authorities on tropical economic products, causes me to hope, and believe, that his suggestion will soon take concrete form and become an accomplished fact. Should there be doubts in anyone's mind as to the necessity of such a college in the Tropics, then I would refer them to the leading article on the subject in the January (1911) issue of *Tropical Life*, where the whole matter is discussed even more fully than Professor Dunstan's time would allow him to do in this work.

I am glad to learn that, thanks to his personal interest in the International Association of Tropical Agriculture, Professor Dunstan has arranged for an English branch to be estab-

lished in London,[1] and that, furthermore, it has been decided to hold the third International Congress in London next year (1912). Having attended both the others—at Paris in 1905, and Brussels, 1910—I fully realized the advantages, as well as the necessity, of periodically holding such Congresses, for the leading experts from all parts of the world to meet together and discuss tropical agriculture, its friends and foes, &c. I only hope that next year the questions of (1) an International Contagious (Plant) Diseases Act,[2] (2) Forest Preservation, and wind and rain belts on highlands, will be placed in the forefront of the programme.

Yours very truly,
HAROLD HAMEL SMITH.

London,
March 1, 1911.

[1] Annual subscription £1. I shall be pleased to give fuller particulars on application.

[2] Those who wish for a detailed list and particulars of a large number of pests and diseases attacking cacao, rubber, cotton, sugar-cane, fruit, &c., will find the last *West Indian Bulletin*, vol. xi, No. 2, 1911, of the greatest use. Price 8d. post free, *Tropical Life* Publishing Department

SYNOPSIS OF CONTENTS.

PAGE

INTRODUCTION. — PROFESSOR WYNDHAM DUNSTAN, M.A., LL.D., F.R.S. (Director of Imperial Institute) on the need of a Tropical Agricultural College ... v.

PREFACE ... ... xxiii.

ESTATE SANITATION AND HYGIENE 1

Results of lecture in 1908—the necessity of manuring as a safeguard against pests—plantation belts—the question of cacao shade—diversify your crops to locate disease—crop-belts and jungle-belts—danger signals—the nourishment of the soil—variations in prices of produce—cultivators on cacao and rubber estates—the peat soil of Malaya—acidity of same and its cure—the effects of nitrate on the yield of Ceará rubber trees—proposal to try it with other varieties—the advantage of using guano on Hevea trees—the summing up—what the Tropics owe to the Schools of Tropical Medicine and our engineers—coagulating in bulk—vacuum dryers.

PROTECTIVE BELTS 49

Mr. John Parkin's opinion—also that of the late Mr. J. B. Carruthers—Mr. Frank Evans quotes Trinidad's (W.I.) experience—what the *Journal of the Jamaica Agricultural Society* has to say on the matter—they recommend *Eucalypti*—so do other authorities—different varieties of *Eucalypti*—the *pros* and *cons* of each—the *Natal Agriculturist* shows the evils arising from lack of forest belts—what their absence has done in Carolina—Stockdale recommends contour drains to prevent erosion

PAGE

of soil—De Freitas, of Grenada, on the "Indiscriminate Destruction of Trees"—Mr. Branch, at Grenada, discusses the needless loss of vegetable matter and top soil—Mr. C. S. Rogers, Forest Officer of Trinidad, W.I., on "Deforestation of Mountain Ridges"—F. E. Kanthack, Director of Irrigation, Cape Colony, on "The Advantages of Re-afforestation"—forests on the Gold Coast—Mr. Thompson's report—the lesson of the Sahara.

STUMP-PULLING 69

Mr. Rudolph Anstead recommends monkey-jacks—*The Planter's Chronicle*, of Bangalore, S. India, on dead roots—the benefits of removing them—warnings against planting a nursery on doubtful or prescribed spots—cost of stump-pullers—the work to be expected of them—the different makes—a Borneo Rubber-Company wisely stump-pulls *and* ploughs to eradicate *fomes*—Mr. Rufus King's (of Iowa, U.S.A.) experience of stump-pulling—planters in Cochin-China believe in extracting tree stumps.

MANURING CACAO 87

General facts—how and when to apply nitrogenous fertilizers—the function of potash—its effects—Anstead in Grenada advocates lime—when to apply it, and how—the effect of lime on other manures—a good system of general manuring—basic slag and potash for mountain land—evils and waste of cacao pods left about—the benefits of manuring—a striking case in Grenada with thrips—remarkable results in Dominica.

HYGIENE IN CACAO PLANTING 97

Remedial measures against pests—strong, healthy trees the surest prevention—the value of cultivating the soil—doing so discourages thrips and

PAGE

other insects—when manuring use what is wanted —what was gained by manuring—what it did for Grenada—the best manure to use—lack of pruning encourages disease.

THE IMPORTANCE OF NITROGEN AS A PLANT FOOD 108

The value of scientific and technical education—nitrogen most often lacking in the soil—nitrate of soda best—nitrogen only one of several plant-foods—skill required when applying nitrates—Stockdale and Hart on the advantage of strong, vigorous trees—what happens on neglected estates.

PROF. HENDRICKSEN OF CUBA ON MANURING CACAO 116

Tropical soil fertility inclined to be exaggerated—what is meant by a fertile soil—the different elements in same—the value of humus—and of lime—comparative yield of cacao per tree in the West Indies—the West Indies *v.* Cuba and San Domingo—Dr. Francis Watts and Manurial Experiments in Dominica—Mr. Joseph Jones in Dominica—a table showing results of experimental work—the value of mulching—but its short supply.

THE MANURIAL REQUIREMENTS OF RUBBER TREES... 129

Up to now but little done—the need and advantages of a radical change—the economy of using artificials—the *difference in rubber soils—how* artificials affect them—what to use—the three kinds—some manuring recipes—good and bad manuring—its effect on the trees—when to apply manures—cattle manures—green manuring.

GREEN MANURING 141

What Rudolph Anstead has to say—also Mr. Stockdale—possible benefits on Ceará—Ceylon the pioneer of green manuring—Zernichow and *Tephrosia*—all about *Tephrosia*—the advantages of mulching cacao—O. W. Barrett on cow-peas—

PAGE

inoculated *v.* ordinary cow-peas—Mr. T. B. Jackson at Antigua on green-dressings—cow-peas—Barbuda beans—table showing results of green-dressings—chicory—sword or overlooker beans—Babricou beans—woolly pyrol—crotalaria—rape—Bokhara clover—thousand-headed kale—pigeon peas—the use of cover crops—their benefits as proved by Ceylon—the ideal cover plant.

PREPARATION OF PLANT FOODS FROM WASTE PRODUCTS 165
How oily residues can be made into valuable manure cakes—how to remove the oil—what can be done with bones, meat, skin trimmings, &c.—how to make valuable plant foods in powdered form from objectionable waste.

INOCULATION AS A CURE FOR PESTS AND DISEASE ... 169
Mr. W. Fox, Penang, on the Angsana tree disease—heavy loss among these trees by disease—Mr. Gallagher's discoveries—*Polystictus occidentalis* the probable cause—inoculation or injection suggested as a remedy—what Mr. Scott-Elliott has done with inoculation—Phytobie funnels—inoculation against black blight in Grenada.

THE TREATMENT OF TROPICAL PLANTS 177
Messrs. Bult s idea—scientific suggestions ignored or neglected—the advantage of scientific planting with rubber and other crops—Mr. Tudhope's report on the Gold Coast industries—the need of constant attention to the trees—early precautions prevent great harm—the necessity of using spraying machines and fluids—the advantages of air and sunlight—the need of care when pruning—the advantages of skilled supervisors—the idea of inoculating the trees against disease—Mr. G. Hartgrink's experiments—results of injecting vegetable fungicides—further investigations necessary.

PAGE

FUNGI PESTS 189

The fungi in relation to agriculture—the various groups of fungi—their manners of life and how they live—animal and vegetable fungi—root fungi —useful fungi—is the red-podded forastero cacao less liable to disease—or the yellow pod more so? —criollo and *pentagona* very liable to disease—Mr. Cradwick on the subject.

GENERAL PESTS 196

The truth about *Termes gestroi*—how serious will it be? — the Colonial Office Committee — what Portuguese East Africa is doing.

CACAO DISEASES AND PESTS 199

Phytophthora omnivora (black or brown rot)—it affects cacao, tea, rubber, &c.—how to distinguish it—is it identical with *Hymenochæte* or *Sporotrichum* or to the *Irpex flavus* of coffee—its effect on Hevea—spraying must be persistent to keep it under. The *Nectrias*—Malins-Smith on canker—also on soil-sanitation and root-canker—trenching for root-canker—Mr. Gallagher on these trenches—Mr. Barrett's opinion—the treatment of, and remedies for stem-canker—beware of empty pods—canker in Ceylon—Mr. F. A. Stockdale on root disease — *Hymenochæte*, *Sporotrichum*, *Dematophora*, *Rosellinia*—where basic slag can be of use—cultivation *must* be resorted to—the style of cultivation needed—the *West Indian Bulletin* on the advantages of a good soil—witch-broom disease—Dr. Van Hall's and Mr. Stockdale's opinions—how Holland attacked the trouble — what epidemics among the trees mean to an estate and to the producing centre—the dangers of one centre contaminating another—the lesson to be learnt from Surinam—white ants on the West Coast of Africa—Hart on white ants and mycelium of fungi—safeguards against white ants—the question of too-close planting — Government work on the Gold Coast

PAGE

— diseases appearing there—spraying machines badly needed—makers not responsive—the Gold Coast Chiefs' interest in the work of the Agricultural Department — the great progress in the cacao industry on the Gold Coast—1891—80 lb. exported —1909—45,277,608 lb. exported—rubber shipments —why cacao planters should watch the Gold Coast —Ballou recommends carbon bisulphide for borers —will noxious gases ever be used on estates to kill out pests — how this could be brought about — Sandman on exterminating white ants—Bordeaux mixture and how it is made and used—Mr. Joseph Jones, of Dominica, on canker-die-back (*Diplodia cacaoicola*) — how it can be combated — again beware of empty cacao husks—Mr. F. A. Stockdale on spraying — reducing shade averts canker in cacao—Mr. Cradwick's remedies—the cost of pest-exterminating measures—Mr. Rorer, the Trinidad mycologist, urges spraying—the dangers of tree-wounds—Boussigniac's patent cacao-pruner.

CACAO BEETLE 255

Remedies suggested in Grenada—egg-collection—baits—again empty husks a danger—how they collect beetles in Surinam—and in Africa—Mr. George Branch, of Grenada, on the pest—also Hinchley Hart in Trinidad.

GRAFTING CACAO 264

What Malins-Smith advocates—Mr. Hart's opinion—also Mr. Frank Evans—grafting *v.* seed-selection —the Imperial Department at Barbados on the grafting of cacao—what Mr. Joseph Jones has done in Dominica—manufacturers' opinion on *T. pentagona*—Mr. Hart on grafting Nicaraguan criollo—Mr. Casse, of Bayeux Estate, Haiti, gives full particulars and illustrations of his experiments with "Budding Cacao" (pp. 275-283)—"The Propagation of Cacao by Budding or Grafting," by Mr.

PAGE

Hinchley Hart, F.L.S., of Trinidad" (pp. 284-292) —"Cacao Improvement by Selection," by Mr. Frank Evans, of the Trinidad Agriculture Department (pp. 292-296).

PART II.

RUBBER SECTION.

RUBBER ON THE GOLD COAST 297

Funtumia elastica—yield compared with Pará - rubber *v.* oil-palms or cacao as native industries - the height of *Funtumia* trees - *Ficus Vogelii* or Memleku rubber—its poor value—Hevea plantations on the Coast—their progressive growth—Mr. Tudhope's (Director of Agriculture) views of Hevea on the Coast—some tapping results—the yields obtained—Ceará and Castilloa at Aburi not promising—progress of Hevea at the Tarkwa station Hevea at the Coomassie (1908) Show—Hevea promising at Tarkwa—Aburi not so suitable general remarks regarding natives as rubber planters—*Landolphia owariensis*—what the Agricultural Department is doing—tree planting at Woburn (England) Experimental Farm - Mr. Cradwick on Rubber in Jamaica - Mr. Proudlock discusses about it in India - Mr. McCall talks of rubber in the Shiré Highlands, Nyasaland - Ceará in Nyasaland—a promising estate near Blantyre —Mr. Gallagher's, M.A., lecture on Pará Rubber - he is against pricking tools for rubber tapping.

TAPPING RUBBER 312

Regarding Castilloa—Carruthers' experience—Stockdale's views—Cradwick speaks well of the Bowman Northway knife for Castilloa—Mr. Carruthers on pricking tools for tapping—punctures—vents—the gouge—the farrier's knife—general notes on tapping by Carruthers—a big yield in Perak—tapping

PAGE

in the West Indies—Carruthers' comments on Castilloa tapping—The Dumont Coffee Co. and rubber—Hevea in French Indo-China and its yield—Mr. Ridley on pricking—tapping *Funtumia*—different methods discussed—is the *F. elastica* a bad yielder?—experimental tappings at Aburi.

RUBBER DISEASES 335

Climate of Malaya—rubber in Malaya—acreage planted—value of same—rubber in F.M.S.—statistics of same—*Fomes semitostus*—soil acidity—manual experiments—safeguards against *Fomes*—a Contagious (Plant) Disease Act needed—Mr. H. C. Pratt busy in F.M.S.—termites—*Eumeces squamosus* (a weevil)—*Astycus lateralis*—*Xyleborus parvulus*, *X. fornicatus*, *X. perforans*—how to check them—lepidopterous larvæ—*Acridium* (a grasshopper) and *Crotalaria*—Kew's help—the value of *a stitch in time*—spraying machines a necessity—pests spread much more easily and quickly to-day—wheat-rust cost India £91,000,000—leaf disease cost Ceylon £15,000,000—plant sanitation the remedy—a bibliography of some pamphlets on pests.

CASTILLOA SECTION.

MR. FAWCETT'S ARTICLE ON CASTILLOA 359

Castilloa may succeed where Pará fails—varieties of Castilloa—Castilloa soils—rainfall—best temperature—the question of shade—how to lay out an estate—distance to plant—catch crops—use a cultivator or plough for weeds—seeds—sowing (Castilloa) seeds—planting out—thinning out.

CASTILLOA YIELDS 368

No satisfactory explanations of failures—lack of reliable tapping figures—Mr. A. E. Casse tells us about Castilloa in Hayti, and how to tap it—De Valda speaks of yields in Panama—Castilloa *v.* Pará on the Dumont Co.'s estate, Santos—Mr.

PAGE

John Parkin on Castilloa yields—Prof. Labroy's views—Manihot the same family as Hevea, but different to Castilloa—the question of congenial surroundings—close-planting in Mexico.

MR. J. L. HERMESSEN ON CASTILLOA IN MEXICO ... 379

The winds around Tehuantepec—planting up forest lands—sowing seed—maize catchcrops—"forest floors," or the sylvan system of culture—tapping with machete—the V system—coagulation—the morning glory vine—the question of moisture in rubber—washing rubber—damage through deep tapping—the best months for tapping—yields—rainfalls in the isthmus.

RUBBER TAPPING IN BOLIVIA, BY MR. F. J. DUNLEAVY 405

The location of the estates—the "estrada" system—*Siphonia brasiliensis* the same as *H. brasiliensis*—the "Lecco" tribe supplies the tappers—the tappers' equipment—present methods employed for tapping and curing—up-to-date methods—the yields—the cost of the rubber—the need of improved transport facilities.

THE CULTIVATION OF CEARÁ, PART I. 417

Kew's summary—how the trees are propagated—the characteristics of the tree—the quality of the rubber—the derivation of *M. Glaziovii*—the question of pricking—the "Hamel-Smith" multiple pricker.

PART II. 421

The new Manihots—Dr. Ule's opinion of them—the characteristics of each—collection and yields—the Maniçobas compared with Hevea—the soils most suitable to the Manihots—the question of nursery beds.

PART III. 425

The *M. Glaziovii* or Ceará—its champions—Jared Smith's (Hawaii) opinion—tapping in Hawaii—

PAGE

Hawaii suits Ceará—Kelway Bamber on the requirements of Ceará—yields in Ceylon—Ceará in Zanzibar—Ceylon prefers *M. Glaziovii* to *dichotoma* —Mr. R. Derry's (Malaya) opinion—an analysis—Ceará biscuit at 9s. 1d.—a badly-grown tree—Ceará in Bahamas—in Hawaii—the tubers or roots—Bahia soils—Ceará liable to break in the wind—some measurements—cattle like the young plants—yields and tapping—notes on Ceará—the question of educating its milk-production—more about tapping in Hawaii—the full herring-bone system—the Bowman-Northway knife—best time to tap—daily tappings *v.* longer intervals—when and why the flow is freest—canvas water-bags to stimulate the flow—unreliability of yield—the need of root observation—the Brazilian sinuous cut for tapping—Dr. Ule on tapping *M. heptaphylla* and *M. piauhyensis*—Mr. Bertram Davis on yields in British East Africa—how to tap—Mr. Stewart McCall (Nyasaland) talks of Ceará yields benefiting by green-manuring—tapping in East Africa—the preparation of the bark—making the cuts—the matter of rests between tapping—the cost of collecting—Ceará in Southern India—a new tapping method in Ceylon—yields at Kuala Kangsar and German East Africa—tapping yields in Uganda and Bangalore.

PART IV. 463

Seeds and Planting—Cardoso's advice—avoid cold winds—pests—nurseries—planting in Hawaii—the germination of the seeds.

PART V. 470

Why Hawaii suits Ceará—Ceará and drought—6-ft. trees fairly immune—tubers and yields again—distance to plant—catch-crops—the "Lewa" system of tapping—punctures.

PAGE

WILD *v.* CULTIVATED RUBBER, BY Mr. W. H. JOHNSON, F.L.S. ... ... • 478

The question of cost—chemical analysis—the preparation—moist Pará *v.* dry plantation—average prices of both—moist Pará pays best—the minimum of cost—African rubbers—analysis of *L. kirkii*—the necessity of improving and standardizing all rubbers.

MECHANICAL APPLIANCES.

PLOUGHING 490

Diplodia and *Hymenochæte*—Lalang ground preferable to fungus-infested soil—stubbing and ploughing a remedy—root-stumping and burning—the advantages of ploughing—choice of implements—first ploughing—the disc plough in British East Africa—particulars of disc ploughs—sub-soils and sub-soil ploughs—the movement of water in soils.

SOIL-SANITATION BY MEANS OF DISC PLOUGHS ... 497

Ploughing to cure root troubles—disc ploughs in the East—various ploughs discussed and described—different soils need different ploughs—Ransome's ploughs illustrated.

THE DESTRUCTION OF PESTS 504

War declared—the Woburn Experimental Farm—Voss's Woburn Bordeaux Paste—their "Fungal" preparation—pest destruction and profit insurance—Messrs. Robinson, Bros., Ltd., offer—Clift's Manurial Insecticide—Clift's Fluid Insecticide—a remedy for white ants—Clift's Fluid for ringing trees—Robinson's White Ant Destroyer—how to apply it—Robinson's Wood Preservative—rat guards—antiseptic coagulant—planters invited

PAGE

to assist in experiments—Messrs. Weeks and Sons, Ltd., spraying machines—the prizes they have won—all sizes made—their power sprayer—spraying pipe-lines for large areas—twenty-three acres sprayed in a day—Weeks' "multi-spray," nozzle.

CORK INSULATION FOR ESTATE BUILDINGS 523

Cork boards for coolness as well as warmth—what Germany is doing with them—how to fix the boards—the advantages of their use in rubber and other factories—early action advised—Atlas Preservative will keep the cork and the buildings free from ants—cork-lined houses cleanest and freest from fire risks—a cork-lined fruit steamer—the necessity of preserving wood buildings from white ants—Atlas Preservative "A" efficacious—but perfect impregnation necessary—why the preservative prevents decay—how to impregnate the timbers—the Preservative Bath—a sworn enemy to white ants, borer beetles, fungi, and rot—its fire-resisting properties—the Assam experiments and their satisfactory results—Atlas "A" successful.

RAT EXTERMINATION 534

The rat population of the U.K.—the campaign in London—Sir James Crichton-Browne on the tactics to be adopted—rats in India—what the plague costs in lives—rats and their fleas the cause—Sir James Crichton-Browne's opinion of Danysz virus—how it affects and kills the rats—Agricultural Boards should work in unison—the rat question in the House of Lords.

RUBBER MACHINERY 540

Our "Tree to Tyre" section—The new Bowman-Northway Double Action Gouge Tapping Knife—clean raw rubber a necessity—dirty cases must be avoided—Kelway Bamber on packing in clean

PAGE

cases—sawdust and splinters cause lower prices—tropical crops must be prepared in bulk—turn your crops out "to type"—why manufacturers ignore small parcels—the leading rubber machinery engineers—Messrs. David Bridge and Co., Ltd.—the medals awarded them—the "Huber" tapping knife—the "Da Costa" coagulator—how it works the advantages of using it—their rubber machinery for washing, sheeting, &c.—Bridge's friction clutch—the question of rollers—rubber drying—the vacuum dryer suitable for all crops—block rubber—its success at the Ceylon exhibition—Bridge's hydraulic press—the "Shaw" coagulating machine—its construction—how it works—Messrs. Francis Shaw and Co., Ltd.—their blocking presses and washing machines—their plan of an estate rubber factory—how to add to same—the Pfleiderer "Universal" washing machine—its mode of cleansing the rubber—the idea of overhead cableways for the transport of latex—the "Universal" at work—the advantages of its automatic self-feeding action.

VACUUM DRYING FOR RUBBER, CACAO, COPRAH, &c., BY MR. J. DARNLEY TAYLOR 575

THE DRYING OF CACAO 582

Cacao, like rubber, must be turned out in bulk "to type"—the "Gordon" dryer—its capacity—dries in twenty-four to thirty hours—how it expels the moisture—over-heating impossible—the "Gordon" machine in the Cameroons and the West Indies—the "Hamel Smith" patent rotary dryer—Messrs. David Bridge and Co., Ltd., sole makers—leading experts speak favourably of it—the system explained—many products can be dried by the same machine—motive power easily solved—the machine regulated to a nicety—two smaller machines better than one large one—buyers can build their own stoves—the Barnard cacao polisher

PAGE

—also made by Messrs. Bridge—how it improves the beans.

TAPPING KNIVES AND ESTATE SUPPLIES... 591

Tapping cups—glass *v.* metal—Messrs. John Yates and Co., Ltd., assortment of cups and tapping knives—the "Burgess" and "Veteran" knives—gouge knives, Jebong and other makes—all by Messrs. Yates — felling axes — dhaws — forks, spades, hoes, &c.—planting bars and spades—why they should be used—mattocks and cacao pruners or reapers — table showing how many trees go to an acre according to distance apart.

LIST OF ILLUSTRATIONS.

	PAGE
FRONTISPIECE	
Professor Wyndham Dunstan, M.A., LL.D., F.R.S., &c.	xiv.
Professor Dr. E. de Wildéman	xvi.
Lt.-Col. Prain, I.M.S., C.I.E., M.A., LL.B., F.R.S., &c.	xxi.
Sir Daniel Morris, K.C.M.G., D.Sc., &c., &c.	xxv.
Dr. Van Hall	2
Dr. J. Sack	3
Mr. H. N. Ridley, M.A., F.R.S., &c.	8
Dr. J. C. Willis, M.A., D.Sc., F.L.S., &c.	12
Mr. O. W. Barrett	18
Davao Natives, Philippine Isles	22
The Late Mr. J. B. Carruthers, F.R.S., &c.	24
Mr J. Hinchley Hart, F.L.S.	28
Mr. Rudolph Anstead, B.A....	31
Mr. Gve. van den Kerckhove	34
Mr. M. T. Dawe, F.L.S.	40
Drying Rubber in Bolivia	48
Llamas and Rubber in Bolivia	56
Rubber in Bolivia awaiting Shipment	68
Rubber Boats on the Amazon	88
The Marquis de Valle-Flor	98
Rubber in Bolivia, The Manager going his Rounds ...	109
Cacao shading Coffee, Guadeloupe	118
„ Tree in Bearing, Trinidad, W.I.	120
Three-year-old Hevea Trees	128
„ „ „ Rubber Trees, overmanured	131
Five-year-old Rubber Trees	133
Four-year-old Rubber Trees, overmanured	135
Rubber in Bolivia : 10 Tons awaiting Shipment... ...	150
Receiving and Weighing Rubber in Bolivia	168
Sir J. D. Rees, K.C.I.E., C.V.O., &c.	175

PAGE

The Heart of the Jungle, Bolivia 187
Smoking Rubber on a Bolivian-Amazon Estrada ... 207
Tapping Rubber in Bolivia, Emptying the Tichuelas ... 214
Cacao in Surinam: Cutting back for Witch-broom Disease 222
Spraying a Cacao Tree after Pruning 224
Cacao and Rubber on the West Coast of Africa ... 232
The late Sir Alfred Jones, K.C.M.G. 234
Budded Cacao in Hayti 277, 279
Rubber on the Gold Coast, West Africa 301
View at the (1906) Ceylon Rubber Exhibition 314
Dr. Huber using his "Huber" Knife in Brazil 317
Scientific Tapping in Brazil 319
Mr. Wm. Fawcett, B.Sc., F.L.S. 360
Pará Rubber in British Guiana 372
Castilloa Rubber in British Guiana 374
Castilloa Rubber in Trinidad (W.I.) 376
The $1,000 Castilloa Rubber Trophy 378
Plantation Landing on Castilloa Estate, Mexico ... 381
Mexican Castilloa, Six Years Old 389
A Mexican Castilloa Estate... 391
Castilloa in the Philippine Isles 394
Tapping Plantation Castilloa by V Incisions 399
Five-Year-Old Castilloa Tree in Samoa 403
Rubber and Snow in Bolivia 406
Tapping Rubber in Bolivia with the Machadine ... 411
Tapping Rubber in Bolivia with Bowman-Northway Implements 413
Llamas with Rubber in Bolivia 415
The New Multiple Tapper for Ceará 420
Ceará Rubber in San Thomé 431
Ceará Tree Tapped on Spiral System 438
Old Ceará Tree in Ceylon 440
A Fine Ceará Tree in British East Africa 445
Ceará and Sisal in British East Africa 447
Ceará (full herring-bone) Tapping in Hawaii 452
Funtumia elastica in Trinidad, W.I. 467
Ceará Root showing Tubers 471
W. H. Johnson, Mr., F.L.S. 480

I. Soil and Plant Sanitation

Mechanical Appliances Section.

	PAGE
A Double Vacuum Dryer: latest type	578
A 3-Furrow Disc Plough	501
An Atlas Preservative Impregnating Bath	531
Axe-ended Mattock	601
"Barnard's" Patent Cacao Polisher	589
Battery of Bridges' Rubber Machines	556
" " Hydraulic Rubber Presses	561
" " Under-driven Machines	557
"Bi-Huber" Tapping Knives, The	549
Blocking Presses by Francis Shaw & Co., Ltd.... ...	564
Bowman-Northway Gouge Tapper	542
Bridge's Improved Vacuum Drying Plant	558
" Washing-Sheeting Machine	557
"Burgess" Tapping Knife, The	594
Cacao Pruner or Reaper	601
Double-backed Bill-hook	596
Felling Axe for Clearing Land	597
"Huber" Tapping Knife, The	549
Manuring Coco-nut Palms in Ceylon	598
Microscopic Investigation of Pests	513
Pipe-lines for Spraying large Areas	520
Plan of a modern Rubber Factory, by Francis Shaw ...	568
Planting Bar	600
Plough for Cultivation and Light Work	502
" " first Ploughing	503
Research Laboratories, West Bromwich	509
Rubber Sheeting Machine, by Francis Shaw	566
" Washer, with diamond-cut Rollers, by Francis Shaw	565
Smoked Rubber by the Da Costa Process	553
The "Da Costa" Coagulator	551
The "Hamel Smith" Rotary Dryer	585
The Jumbo Plough	499
The "Shaw" Coagulator	562
" " Vacuum Drying Stove	563

	PAGE
The Special Ridging Plough	499
The "Universal" Washer at work	570
" " " Tilted to Empty Contents ...	572
Week's Knapsack Sprayer	518
" Machine on Runners	517
" Power Spraying Plant	519

ERRATA

Page 110, line 19, *for* "Each of these" *read* "Each of the."

" 238, lines 23 and 24, *for* "bisulphide into" *read* "bisulphide injected into."

" 328, line 20, *for* "fitted" *read* "shaped."

" 378, illustration, line 3, *for* "to the best" *read* "for the best."

" 448, line 21, *for* "165" *read* "365."

" 453, footnote, *for* "Thess" *read* "These."

" 480, *under* illustration, *read* "Mr. W. H. Johnson, F.L.S."

Soil and Plant Sanitation

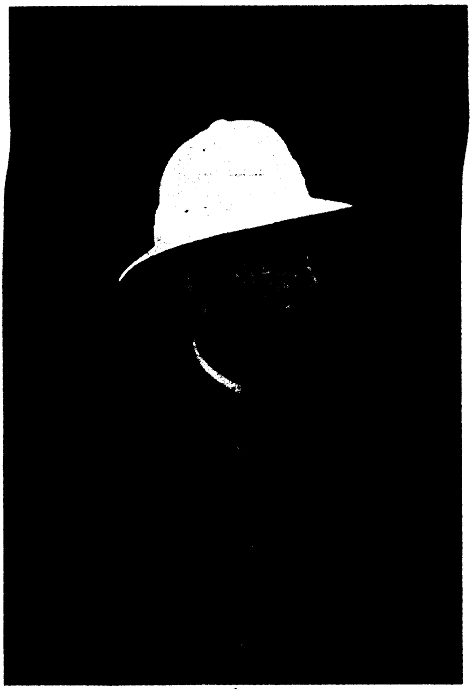
ON

CACAO AND RUBBER ESTATES.

ESTATE SANITATION AND HYGIENE.

SINCE 1908, when I lectured on "The Future of Cacao Planting" before the Royal Horticultural Society, cacao-planters generally have shown, or appear to have shown, more interest in their trees, and seem more willing to spend money on manuring, spraying, &c One planter, for instance, in Jamaica, who appeared very sceptical about the value or utility of manuring the trees, tried first some basic slag, to remedy the sour patches of soil with which his estate was troubled, and then some complete manures for the trees. In both cases the results were so satisfactory that—to my knowledge—two repeat orders have been received ; so I hope that, as in this instance, the debate at my lecture, which was

published in book form, may have helped to make planters realize that unless they manage



Dr. Van Hall,
Who fought the Witch-broom Disease in Surinam.

their estates on more hygienic methods, they cannot hope to permanently succeed.

Even if they go on making a profit for some years, later on, just as they are thinking of settling down to live comfortably on the proceeds from their estate, they will

DR. J. SACK,
Of the Experimental Station, Paramaribo, Surinam.

find, as in Trinidad, that lack of plant food and cultivation has caused the crop to fall off and the trees to become badly diseased. In Surinam it was just the same; Bahia a few

years back and San Thomé lately, have both had bad epidemics, which could have been greatly minimized if taken in time. The witch-broom disease in Surinam is being vigorously combated, thanks to Drs. Van Hall, Sack, and Droost. Bahia seems better with the die-back, but San Thomé is not making much progress with the "Nourriture brune," nor is Trinidad (in spite of Professor Carmody's advice) attacking the trouble of the Nectria as vigorously as she ought to do now that Mr. Rorer's recent investigations have added so much to the local knowledge of the disease. Probably this disease is due to *Phytophthora omnivora*.[1] Until both these centres make active and persistent efforts, San Thomé with phosphates and basic slag, to remedy the sour soil, and Trinidad by means of attention to drainage, better cultivation, and a more general use of sprayers and spraying fluid to first stay the ravages and afterwards to exterminate and prevent its recurrence, no improvement can be looked for. With Trinidad

[1] See Rorer's paper in Bulletin of the Department of Agriculture, Trinidad, vol. x., No. 64.

—if not San Thomé—her individual crops will continue to decrease; so that her exports, in spite of fresh cultivations, will not show any regular and reliable augmentation, simply because the planters cannot see their way to support Professor Carmody and his staff in their efforts to free the trees from disease.

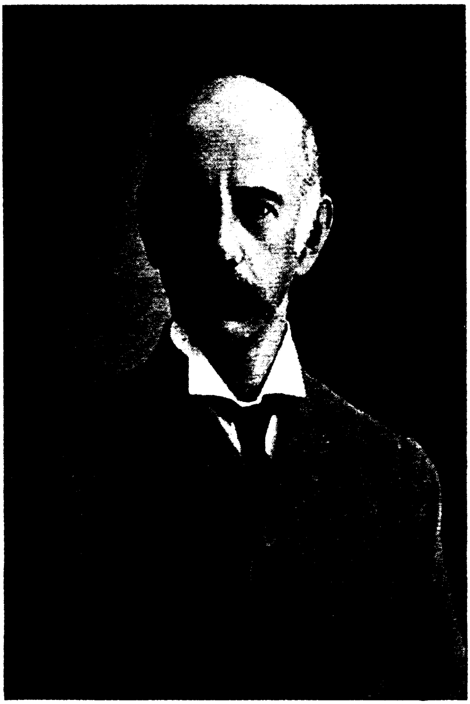
With the increased areas being put down under cotton in Mexico, and other centres planting up new estates, I hope that my proposals to plant the main crops, cacao, rubber, or otherwise, in blocks, with a secondary crop surrounding them, may become more general. Caravonica, mamara, and other cottons, could very well be used for planting up these belts, either alone or for some years under coco-nuts. If this is done the trouble can be vigorously treated before it spreads all over the estate, perhaps going, as in Surinam and Trinidad, from one estate to many others and finally spreading through the entire centre. My friend, Dr. Latour, reports that he has planted caravonica with considerable success in Tobago, between the coco-nut palms, planted 30 ft. by 30 ft., or forty-nine trees to the acre. The caravonica was planted at 6 ft. by

6 ft., and it is reckoned that a crop would be forthcoming from the trees for six or seven years. The new mamara cotton of Messrs. Sturmfels, at Brisbane, or Messrs. Svensen *and D'Oliveyra in the Solomon Islands* (the latter are, I believe, the originators of this new cotton) is well worth the trifling cost of experimenting with, to see if it will grow to advantage as a belt between the cacao, either under coco-nuts or alone, and if it is likely to prove a reliable safety-belt for restricting pests and disease to a small area. The cotton was valued by experts in London, on March 22, 1910, at 15d. per lb., as against $15\frac{7}{16}$d. for good fair Egyptian, and about $8\frac{15}{16}$d. for good middling American. Had the fibre been stronger it would have been worth more, probably 18d. per lb., as it is of a good length and silky. Naturally the price of this and all long cottons is affected by the price of Egyptians, now high on account of short cotton crops, both there and in the States. Cotton, of course, is inclined to attract scale insects if left to get old; and Mr. Stockdale warns me, it will not grow satisfactorily where cacao flourishes as a rule, if ever. The climate is too hot—or

should be—and diseases play havoc. Grenada and Trinidad have both experimented with cotton in cacao districts—*at the expense of the experimenter*. Cotton in Tobago does not flourish in the cacao portion of the island, but in the old abandoned sugar estates near the sea-shore. Cotton from wet districts is always weak, unless the soil is of a nature peculiarly suited to that crop. Mr. Stockdale also believes in isolating areas of a single crop; but in the West Indies and British Guiana he considers that rubber or coffee should be preferable as alternate crops to grow with cacao. Bananas, on the other hand, according to Mr. Cradwick, in Jamaica, do not seem to attract this pest. Cotton, Mr. O. W. Barrett warns me, cannot be grown in localities suitable to cacao and rubber except on lands with a light soil and low rainfall, near the coast.

Two years ago cacao planters, as a whole, were much more wedded to the use of "shade-trees" than is the case to-day. Even now much damage is aggravated and encouraged by insect and other pests, and valuable crops are curtailed owing to the cacao being over-

shaded. The evil, I fear, has not been remedied to any extent worth noting; but, as if to



MR. H. N. RIDLEY, M.A., F.L.S., F.R.S., &c.,
Director, Botanic Gardens, Singapore.

make up for my disappointment, I have heard and seen on all sides a general approval of the

ideas I advanced, viz., in nearly all, if not all, those centres where disease is rampant. No permanent improvement to mitigate the evil, however, can be expected, until the question of over-shading is seriously taken in hand, and not only the permanent shade (the Erythrinas, &c.), removed wholly or partially, but the cacao trees themselves kept pruned back more, so as to let light and air play about the trunks and roots. At the same time, it is good to remember that if you let in too much sun your trees, in the dry season, tend to become partially disabled, and the yield delayed and diminished. Therefore, in doing this, as with everything else, the planter must use his discretion. It is not necessary, it may even be downright harmful, to remove *every* shade-tree on an estate; and when pruning back the cacao trees, too much light may be introduced, which would cause over-evaporation to take place and even cause the ground to dry up and crack. Such an occurrence must be avoided at all costs.

As to the benefit to be derived from the judicious removal of shade trees, the encouragement of new supplies in the place of old

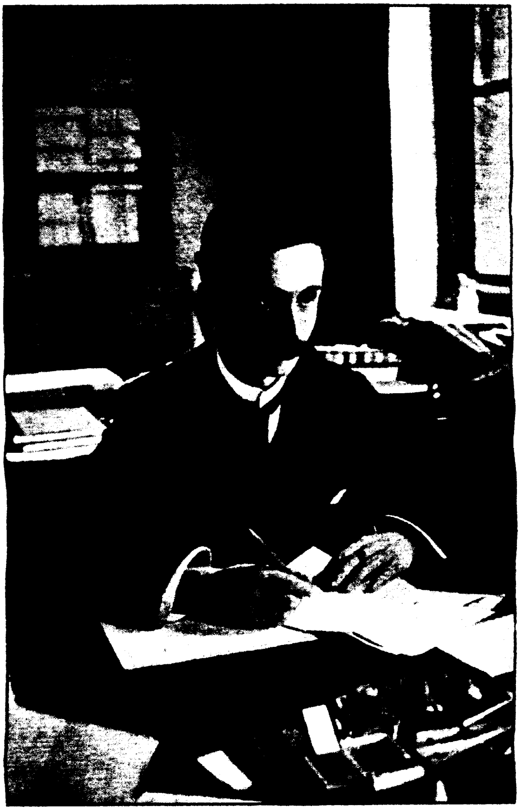
stems, and careful pruning, the figures given by Professor Harrison and Mr. Stockdale in the Progress Report on the Experimental Agricultural Work of British Guiana for 1908-09 are worthy of special notice. The crops of the years 1908 and 1909 were by far the heaviest in the cacao experiment plots, their yields being 3,860 and 4,760 lb. of cacao respectively, as compared with a mean annual yield of 1,060 lb. during the five years prior to the reduction of the shade trees, and with an annual yield of 1,870 lb. during the six years immediately succeeding that reduction. These cacao trees were very densely shaded with *Erythrina glauca*, and the crops were not satisfactory. The shade trees were cautiously thinned out until about three-quarters of them had been removed. Those left standing served as a belt for protection against wind on the windward side of the field, while a few heavily-pruned shade trees were left scattered throughout the cultivation. This letting in of light and air was gradual, and the cacao in no way suffered. The average returns, as shown by the above figures, show an average increase of 79 per cent. over the original crop

during the six years succeeding the reduction, while the subsequent crops have been very much greater. Evidence such as this, answers the critics of "reduction of shade," and the subsequent larger crops bring the matter of careful reduction of shade within the realm of practical politics for the cacao planter.

I have always urged estate-owners to plant more than one crop. When laying out a cacao estate, I would suggest that the following plan be adopted. This gives 14,400 trees of the main crop to each block, to be surrounded by as different a tree as possible—one that, above all things, would not encourage insects and diseases with which the main crop, *i.e.*, the cacao or rubber trees, is most liable to be attacked. Whether cotton under coco-nuts, or coco-nuts alone or with bananas, or bananas alone, can do this, remains to be proved. If not, sisal or other fibre plants might be tried.[1] Rubber, now that it is being planted up over large areas, seems likely to be as troubled in its "civilized" state with disease and pests

---

[1] The *Ficus Rigo* of Papua is said to get along well with cotton, fibres, &c.



DR. J. C. WILLIS, D.Sc., &c.
Director, Royal Botanic Gardens, Ceylon.

as any other cultivated crop, covering a wide area without a break. A break, or breaks, therefore, must be introduced, whatever the crop is that you wish to cultivate with success, and, as I suggest later on, even original belts of forest lands should be left for that reason. Until this is done, coffee, coco-nuts, tea, cacao, cotton, and now rubber, will continue to be set up and looked upon as immortal in turn, only to be struck down at one centre or another and well-nigh, if not completely, exterminated, owing to an unlooked-for epidemic that will appear and flourish as rapidly, or even more so, than the trees themselves, until in the end the disease wins and the industry receives its quietus. In Ceylon, where the planters' motto is "Never say die," a new crop has each time been introduced and planted up almost as rapidly as the previous one was killed out, but this only helps to prove how necessary it is to have more than one main crop. When the history of tropical agriculture is written, Ceylon and her planters should be given the place of honour, both on account of their grit and perseverance under the most adverse circum-

stances, as well as for the example they have set others of studying agriculture seriously, and to treat and tend the estates and crops on hygienic lines, similar to those applied to human beings and animals.

Pour revenir à nos moutons, the plan I suggested for planting up estates was as follows :—

```
      R.                                   R.
    A C A                                A C A
R C C C R R R R                  R R R R R C C C R
  A C A A A A A                      A A A A A C A.
      R A                                A R
      R A                                A R
      R A       All cacao or main crop-   A R
                planted 120 × 120 trees =
      R A       14,4CO trees to the block.  A R
      R A                                A R
      R A                                A R
  A C A A A A A                      A A A A C A
R C C C R R R R                      R R R C C C R
    A C A                                A C A
      R                                    R
```

A = the main or chief crop—say cacao.

R = the alternate crop to serve as a belt—say rubber or coco-nuts and cotton, or cotton, &c.

C = a third crop to break up the belt, so as to avoid disease running around this in turn.

A = twelve rows of cacao.

R = six rows of rubber or other alternate crop.

The gaps denote where belts can be further introduced if a "piece" of 14,400 trees is considered too large.

If original forest belts are left, they must be wide; otherwise, Mr. Stockdale and also Mr. Gallagher, object to their use, the former because the trees fall down very rapidly and often do considerable damage. Forest trees in the Tropics are, by force of circumstances, surface feeders entirely, and therefore when thin belts are left there is nothing for them to do but to blow over, unless sufficient are left to give mutual protection. Mr. Gallagher queries whether these belts would not be too narrow to prevent diseases, except, perhaps, root disease. "Jungle belts," he writes, "not less than a mile wide and following high land are the best. Narrow jungle belts, of ten chains, say, are worse than useless; as, among other disadvantages, the big jungle trees are inclined to slowly fall within the cultivated area and do damage. A rich secondary growth springs up which attracts deer, rats, and insect pests, and the decaying timber at such close quarters is not good."

On model estates in Mexico, wide roads are left, partly to restrict pests, partly for transport purposes, but in all cases to minimize the danger of estate fires. To do this, the roads want to be 25 or 30 ft. wide, and in some centres this is not convenient. It may let in too much wind, or take up too much room, &c. The idea otherwise, however, is a good one.

When weakened or diseased, O. W. Barrett says that Hevea, Castilloa, and Ficus rubbers are all open to attack by *Botryo-diplodia elasticæ*, as are also coco-nuts. The fungus is identical with *Lasiodiplodia theobromæ*, causing die-back and brown of cacao.[1] Other diseases—*e.g.*, pink disease—are probably common to Hevea and other rubbers and cacao.

Petch maintains that cacao and Hevea *cannot be planted together*, as their diseases are identical. Even then a belt of one or the other would not make disease-attacks more certain.

[1] See Petch's writings on this; also, *Agricultural Journal*, Botanic Gardens, Ceylon, vol. iv., Nos. 23 and 24.

Writing to me about "danger signals," on rubber and cacao estates, Mr. O. W. Barrett, who is now in the Philippines says :—

"After a dozen years' experience in as many tropical countries the plant doctor must needs be only too familiar with the common faults of the average planter. With apologies to the unprogressive estate owners, who, for one reason or another, persist in following their time-honoured but deplorably wasteful and frequently dangerous methods, let us draw up a 'black list' of errors (for only those who have not run far) to read :—

(1) "Calling some soils poor and some rich is unjust; they are active or lazy, hungry or dyspeptic, but the microbes that live therein and the air and water that travel through—*they tell the story. Hence every planter must play* at being a sanitary engineer as well as a practical bacteriologist; he must ventilate, drain, irrigate, and ventilate again—for roots must breathe as well as eat and drink, and he who allows them to suffocate, or drowns them, or poisons them with decay-ferments and acids, or unwholesome food-materials, is guilty of self-robbery *at least*.

[Reproduced from *Proceedings of the Trop. Agric. Soc.*]

CACAO IN TRINIDAD (W.I.): MR. O. W. BARRETT IN THE FIELD.

(2) " Radical ploughing operations in young plantations, *i.e.*, the breaking of feeding roots, is about as bad as no tilth at all. 'Forking' with spade (or fork) and cutlass (to chop the roots that get in the way) is a sad sight. Vertical forking[1] not only ventilates the soil-mass, but allows the normal surface materials prepared by the aerobic decay germs, to get down through the prong holes into the feeding space of the fibrous crop roots. By the smooth, packed surface method the planter permits most of his plant foodstuffs to wash off and flow seaward in solution.

(3) " An unconscionable amount of good humus and potential plant food is burned up or held in a soluble form by overdoses of lime; digesting a modicum of such raw material is a boon to the hungry root, but when once dissolved the surplus is carried beyond the reach of the root-hairs and the gaping drain gets it. One overdose of lime may impoverish the soil for a period of several years; properly administered there is no better 'fertilizer.'

---

[1] Originally recommended in the addresses before the Agricultural Society of Trinidad and Tobago in 1907.

(4) "The amount of money that has been wasted in the application of chemical manures of the wrong kind, at the wrong time, and in the wrong manner is a sad subject.

(5) "The compost tank or pit is conspicuous by its almost utter absence on estates, yet every proprietor admits its economy in theory, even when he has never seen its manifold practical advantages.

(6) "The dearth of books, periodicals, and scientific apparatus pertaining to economic agronomy and the practical ecology of major and minor crops, is a phenomenon concomitant with the too frequent and inexcusable indifference—not to say ignorance—of the tropical planter; however, men of the rising generation are beginning to consider what a plant is and how it lives and how its health affects their wealth. I verily believe that the 'future pound' must look out for itself by-and-by, though the 'present penny' is still far more popular.

(7) "Perhaps no other question in tropical agronomy has been, and is, so woefully neglected as that of cover-crops. The four-fold use of the various leguminous green-

manure covers is a subject that the planter can afford to sit up nights over; it is a matter of many millions annually to cacao and rubber producers alone. Wherever weeds *would* grow, cow-pea, lyon bean, velvet bean, canavalia, crotalaria, or something similar *should* grow.

(8) "Probably 95 per cent. of the soil inoculation experiments have been failures; it is a long story; but if the planter must inoculate his legume fields let him follow the *wheelbarrow* rather than the 'culture' process; fresh earth from an old to the new field, with active bacteria by the billion, instead of dead or dried-up laboratory specimens. The *theory*, however, is excellent, and some day the practice may be *compulsory*.

"By the way, there is not much hope of success with *any* cover in a sour, packed soil where the nodule bacteria cannot exist, or in the dark, gloomy interspaces of the old-fashioned over-shaded cacao grove.

(9) "Soil analysis is another grave error to which many good planters have pinned their faith. The plant itself, however, knows a great deal more about what the soil *is good for*

DAVAO NATIVES, MINDANAO, PHILIPPINE ISLANDS.

The costumes are made of hemp-cloth, decorated with beads and belts of native manufacture. In the centre are two "headmen," appointed chiefs by the Government.

than does any test-tube in the laboratory. The bacterial flora and the physical texture are much more to be relied upon—with all respects to the chemists—than quantitative tables of mineral constituents.

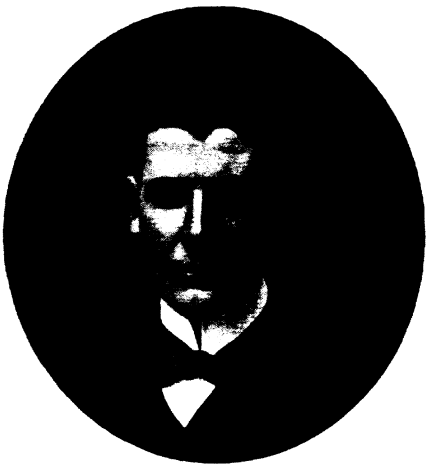
(10) "Very few planters understand (or at least *appreciate*) the tremendous injury caused by the excretory poisons from grass roots. The scientific explanation of grass poisoning in plantations was given to the public only some three years ago, but already a few planters are taking action.

(11) "Enough has been written upon the 'stitch-in-time' policy of dealing with fungus and insect pests to have long ago removed the bane of hebetude and culpable negligence that causes such tremendous losses from these causes on the average plantation; yet it will continue, and the only good about it is, that the aforesaid bane puts a genuine premium on intelligence and painstaking effort.

(12) "Unsanitary pruning, 'picking,' and wound treatment on cacao estates are also excessively common methods of self-robbery practised on tropical estates. One *can* amputate a limb (human or vegetable) and leave it

' undressed,' but what about being the patient-victim?

"There is one very unfortunate feature about advising or warning tropical planters:



THE LATE MR. J. B. CARRUTHERS, F.R.S., &c.,
Formerly Director of Agriculture, F.M.S., then Assistant Director at Trinidad, W.I.

viz.: the difference between the actual conditions on any estate and those of any other is always considerable; *procedures and policies which* just fit *one* seldom precisely apply to *any other.* And upon this point rest the glorious oppor-

tunities of the fundamental 'personal equation' in the struggle for wealth from plant-products through good judgment and hard work."

On whatever lines, however, you choose to lay down your estate, it must be remembered that you have still to nourish your trees by replenishing the soil with those constituents which the crops remove, especially in the case of cacao and rubber, and which will never be returned to the ground unless by the planter. Just as it is certain that all trees and plants, when cultivated over large areas, are liable to disease, so it is equally certain that the best, perhaps the only way, to render them immune from disease is by making them strong and healthy, and so able to withstand the trouble; or if they become affected to enable them to throw it off. This has been proved over and over again, both by accident and on purpose. It is, however, impossible for the trees to remain strong and vigorous unless the land is adequately drained, and great care is constantly bestowed on their cultivation and the management of the soil, as well as to the proper treatment and feeding of the trees.

First, therefore, plant your estate on scientific

lines, so as to isolate disease or other trouble should it appear. There is no need to follow the plan that I have advocated; I may be getting out of date, as it is some years since I was on an estate; and those now in the Tropics may suggest a better one, only I tell you to adopt some plan of isolation. The second crop, that you interplant the first with, will help to distribute your risks financially, as well as providing a safeguard against disease. In 1907 cacao was up to 120s. per cwt., and hard Pará down to 2s. 9d. per lb. Since January hard Pará has been over 12s. per lb., and cacao is inclined to go below 50s. It will be wise, therefore, to run these two crops together when possible. Cotton and coco-nuts are now selling at high prices. The latter used to sell in London with difficulty at 50s., I believe at times as low as 30s. per 1,000, including the freight, but to-day in the West Indies you get over £4 10s. On March 5, 1910, the price quoted at Port of Spain, Trinidad (West Indies), was $23, and in October $28 per 1,000 f.o.b. for selected peeled nuts in bags, and the buyer has still to pay the freight home. Therefore, I advise you to—(1) Isolate your crops, (2) distribute

your risks. Then I tell you—cultivate, cultivate, cultivate. If you can do nothing else, try "vertical forking," *i.e.*, lightening up the soil by pushing a fork in, and then cracking the soil without turning it. Where ordinary forking cannot be practised every year, vertical forking is of advantage, as it lightens up the soil with the minimum of harm to the roots. Cacao is a delicate crop, and too much ordinary forking in unsatisfactory seasons may prove disastrous, and one cannot always depend upon proper seasons, not even in the Tropics. Let in air and light, first to the trees, and then, by turning up the soil, to the roots. Hart claims that forking near palms is dangerous, and that as good results are obtained by mulching, which also brings earthworms, and they cultivate the soil. Until you do this the trees can never give of their best. You must see that the soil does not become hard and packed; cultivate it to receive the rain water and moisture as they descend from above, and so enable the ground to give out the plant food in the humus and soil, and then to pass it on to the trees. As Mr. Gallagher says, there is much less soil washed away and more water

Mr. J. Hinchley Hart, F.L.S., &c., "Cacao Hart."
For many years head of the Trinidad (W.I.) Botanical Department.

retained on cultivated areas. However good and rich a soil may be, it must be properly cultivated; nothing is of greater importance than this keeping of the soil moist and porous. All your science, and all your money — those millions now being so willingly poured into the Tropics by the dwellers in the more temperate zones—will be of no avail in keeping your trees strong and healthy and procuring you large crops, if you are neglectful in your attention to the hygiene and sanitation of your estate and trees. How often have I pointed out, both on paper and in my lectures, that the higher the standard of cultivation the greater the freedom from pests and disease, and the larger the crops. *The crop* — that is what you want: the alpha and the omega of all your work and anxiety. Be careful, therefore, at the start, and see that you do all that can be done to ensure large and regular crops. A rich soil in itself is not sufficient; the plant-food and constituents may be there, but the plants may not be able to absorb them. Ploughs and cultivators will have to be introduced; they are bound to come on cacao and rubber estates. Those who have only half the experience I

can claim, laugh at this idea, as they have done at many others I have recommended, but all of which are now in everyday use on well-regulated estates. Meanwhile I notice that Mr. Frank Evans, attached to the Trinidad Agricultural Department, but temporarily engaged by the Hawaiian Sugar Planters' Association, has long advocated the use of cultivators on rubber and cacao plantations. In use on some of the Hawaiian sugar plantations, he tells me, are two implements which would be of great value to the cacao and rubber planters. The first is Horner's deep tillage implement, which would carry out the idea of "vertical" forking far more effectively and at a much less cost than the old-fashioned fork. The second is Horner's cultivator, which consists of ten long teeth or tines, slightly bent at the ends, which tears out and collects the grass and weeds into piles. Later on the same implement is used to pull down and distribute these piles of decayed vegetable matter. Rudolph Anstead agrees with me in principle about ploughing, but says that to do so is impossible in many tropical places. It is so, he claims, in Travancore, because of the steep slopes for

MR. RUDOLPH ANSTEAD, B.A. (Cantab.),
Planting Expert to the U.P. Association of S. India; formerly Agricultural Superintendent at Grenada (W.I.)

one thing, but chiefly because they are unable to procure cattle, which cannot be kept by estates on account of the forage difficulty in the dry season, and they cannot be borrowed from the villagers because they are wanted for ploughing just at the same time that they are required by the estates, and the natives can hardly keep enough for their own purposes. Estate owners would run bigger herds of cattle for their manure if they could. Of course, you will say use mechanical traction instead of cattle, but labour is so cheap that forking is more economical. Mr. Ridley, the able Director of Agriculture (or, to be strictly correct, Director of Botanic Gardens) at Singapore, gave an excellent example of this in his October, 1909, bulletin, in his article on "Peat Soils in the Malay Peninsula." Here you have a soil formation consisting exclusively of dead timber roots and decayed leaves, often to a depth of 20 ft. "What beautiful stuff for my garden!" says the European householder. This may be, when it is in the European garden mixed with the soil there, but in the Malay Peninsula, although *Hevea brasiliensis* is a typical *hygrophyte*, according to Mr. Ridley, "that

is to say, a plant adapted for growth in the wettest regions of the Tropics; yet in these so-called peat soils the mortality among the plants is described as being 'frightful.' The dead ones were replaced in vain. The plants all looked sickly and died, some from attacks of *Fomes*, others, perhaps, from termites, some from unknown fungi." Here, therefore, you have soil rich in plant-food, but which, owing to excess of humic acid, &c., in the water, was totally unsuitable for rubber or cacao.

Acidity in peat soil, Mr. Gallagher reasons, is the cause of the failure of the trees to develop. Drainage and lime usually cures it, unless the peat is very thick through, say, more than 3 ft. deep. If the trouble is not cured, the young shoots, about nine months after planting, shrivel up; new ones come out, only to wither in their turn, and so on, until the plant looks like a bushy shrub. Lime is, or should be, applied as follows: Three holes are made equidistant from each other, and as far from the tree as 1½ ft. or 2 ft. for each year of the tree's age. The holes are made with a sharp-pointed stick about as thick as a man's arm. The stick is worked in until stagnant

water is reached, when a double handful of lime is thrown into each hole, which is then

MR. GVE. VAN DEN KERCKHOVE,
The well-known authority on Congo and other Rubbers.

filled up. This treatment is repeated as soon as the delicate top leaves show the least sign

of wilting; or the soil is tested with blue litmus paper, and found to require attention.

Good water, drainage, cultivation, and pruning, therefore, are equally necessary on your estate if you wish to succeed, and form No. 3 in my table of necessary methods to ensure success; No. 4 is the application of manures and fertilizers. On this subject I have published and preached so extensively that I feel that I need not trouble you about my ideas on this point again, except to call your attention to the direct benefits obtained through increased yields by the application of nitrate of soda to Ceará rubber trees. If this is so with *M. Glaziovii*, it should be worth trying similar experiments on other rubber, Hevea, Castilloa, Funtumia, &c., especially with Castilloa in the West Indies, and Funtumia in Africa, where the trees are found, as some report, to be such poor latex yielders as to tempt the owners to remove them. The following account of the experiments carried on in Hawaii is from Bulletin No. 19 of the Hawaii Experimental Station, under the guidance of Mr. E. V. Wilcox and Mr. Q. Q. Bradford, and was published in *Tropical Life*, March, 1910.

The Effect of Nitrate of Soda upon the Flow of Ceará Latex.

From the time that plantation rubber first came to the front we have been steadily advocating the necessity of adequately feeding the trees by means of fertilizers, first of all to replace that which you take away in the milk, and secondly to try and increase not only the yield of the milk, but the percentage of the rubber contained therein. To show how correct we were in our ideas, we reproduce the following from Bulletin No. 19 of the Hawaii Experimental Station. The author of this brochure, which is entitled "Experiments in Tapping Ceará Rubber Trees," is Mr. E. V. Wilcox, Special Agent in charge of the Experiment Station. The experiments were arranged by Mr. Wilcox in consultation with Mr. Hosmer, then Territorial Forester, and the actual tapping was done by Mr. Q. Q. Bradford, Assistant in Rubber Investigations, and the labourers under his direction. In his report Mr. Wilcox acknowledges the active co-operation of the directors of the four rubber plantations on Maui in allowing their trees to be experimented on, and in furnishing the

labourers and accommodation for Mr. Bradford when carrying out the experiments :—

"While fertilizers have been used in rubber plantations for increasing the growth and vigour of rubber trees, we have found no record of experiments to determine the possibility of increasing the flow of latex temporarily during the tapping period. It is apparent that if the flow can be considerably increased by the application of a quick-acting fertilizer, economy will be secured in the operation of tapping and collecting latex. The first experiment with nitrate of soda was carried out at Keanae, Maui, on Ceará rubber trees averaging 14 in. in circumference. A uniform series of trees was found and divided into three groups, which received ½ lb., ¼ lb., and no nitrate of soda respectively. Before applying the nitrate of soda, the yield of the whole group of trees was tested by means of uniform tapping. The weight of dry rubber from three trees which received ½ lb. of nitrate of soda each was 2·3 oz. ; from three trees which received ¼ lb. of nitrate of soda 1·3 oz. ; and from the three unfertilized trees 1·2 oz. The nitrate of soda was placed in the soil at a depth of 3 or 4 in.

and at some distance from the trunk, around each tree, where it would most quickly become available to the roots. The weather was rainy during the experiment, which extended over a period of about two weeks, and the nitrate of soda was therefore rapidly dissolved and utilized by the tree, or washed away in the drainage water. The effect of the nitrate of soda upon the flow of latex was manifested within forty-eight hours.

"A similar experiment was made on rubber trees growing on Tantalus, averaging about 12 in. in circumference. The soil about these trees was very loose and porous, and, at the time when the nitrate of soda was applied, was unusually dry. After applying the nitrate of soda the soil was thoroughly irrigated. The results from tapping these trees indicated that the nitrate of soda was almost entirely washed away by the heavy irrigation, so that little effect was noted in the amount of rubber obtained from trees to which the fertilizer had been applied. The flow of latex was, however, in all cases somewhat more vigorous from trees which had received nitrate of soda, *and coagulation of the rubber from the latex took place*

more promptly. In a subsequent test, in the same locality, upon other trees, the yield of rubber was doubled by the application of ½ lb. nitrate of soda per tree. In this case the soil was moist at the time of the application of the fertilizer, and no irrigation was applied during the experiment. Under ordinary conditions, on the windward side of the islands the soil is sufficiently moist at all times to render the nitrate of soda promptly available.

"The matter of the influence of nitrate of soda upon the latex was considered sufficiently important to be put to a further test on rubber trees near the station office. These trees were about 11 in. in circumference. From one group of five trees 0·9 oz. of dry rubber was obtained in three days before applying the nitrate of soda, and 1·3 oz. from the same trees in the three days following the application of the fertilizer. In this case each tree received ½ lb. nitrate of soda. On another group of five trees the yield of rubber during the three days before the nitrate of soda was applied was 0·9 oz., and during the three days following its application 1·2 oz. It appears, from these experiments, that the flow of latex may

MR. M. T. DAWE, F.L.S.
(After whom *Landolphia Dawei* was named).

Formerly of the Botanical Department, Uganda, now Director of Agriculture of the Cia. da Moçambique.

be temporarily stimulated by applying nitrate of soda. It now remains for the planters to determine the exact economy of the method by applying it on a large scale as soon as their rubber trees become mature."

Such results should, and probably will, encourage planters of all varieties of rubber, Hevea, Castilloa, Funtumia, &c., to try the effects of nitrate of soda on their yields. When they do so, I trust that they will favour me with the results of their experiments, and let me know whether the temporary stimulus given to the trees in any way effects their yield later on.

As a further example of how manure can benefit rubber trees, it is worth noting from the *Straits Bulletin* that a planter from the Dutch Islands recently visited the Singapore Gardens, and in the course of conversation stated that he had found a remarkable increase in the growth of his Pará rubber trees after using guano (which is a complete manure) imported from Europe. A small quantity was put round each trunk in a shallow trench surrounding the tree and covered in with soil; the cost was 3 cents a tree. That is, I take it, Dutch cents, a hundred of which go to a

florin, worth 1s. 8d., or 5 cents to a penny. As the editor of the *Bulletin* very truly remarks, this inexpensive method of manuring might be very useful in bringing on young plants. I have always urged rubber men to include guano in their experiments; it can do no harm to do so. Now that we know the growth of the tree can be so greatly increased by its use, and the tapping area thereby more rapidly extended, I hope that planters will take up the matter and try guano, when procurable, on their estates. Experiments carefully carried out do no harm, and often do immense good.

Experiments carried out at Singapore tend to show that by applying a complete manure (including potash) to Hevea trees two years old, an *annual increase* in girth or circumference of 2·52 cm. was obtained. This it is calculated was equal to 10 cm. in four years. Roughly speaking this means that, from a tapping point of view, the planter gains a clear year by the application of a complete manure.[1]

[1] *L'Agronomie Tropicale*, 1910, No. 4, p. 96.

I will conclude this portion by repeating the four most important items necessary to ensure success when establishing rubber or cacao estates in the Tropics.

(1) Isolate your crops.

(2) Distribute your risks.

(3) Irrigate with good water; drain, aerate, and cultivate adequately.

(4) Manure regularly to replace rather more than you remove.

Perhaps a fifth is necessary.

(5) Act with discretion, caution, and moderation.

Having dealt fully with the "hygiene and sanitation of the trees," I would like to call attention to the splendid work that the London School of Tropical Medicine, and other similar institutions, are rendering to the industries in attending to the hygiene and sanitation of the planter and his environments. Their efforts alone can render possible the exploitation of vast districts in Africa and elsewhere, where otherwise the Stegomyia, Anopheles mosquitoes, tsetse-flies, and other pests would keep the white manager, if not the native collector, at arm's length. Medical research, by

enabling white managers to supervise native labour on the spot, is enabling the estates to prepare what were hitherto unattractive rubbers on the most approved scientific lines, and to export Funtumia and Landolphia sheet or biscuit on a parity with their Eastern competitor, to an extent that was impossible a few years and even a few months back. What capital is doing to extend the area under plantation rubber, tropical medical science can well claim to be doing to extend the area of scientifically exploited wild rubber.

After the medical scientist we owe a word of praise to the engineers—Passburg, of Berlin, or James Livingston, of London—for their vacuum drier; Ernest Scott (London), Francis Shaw and David Bridge (both of Manchester), for similar drying chambers. These, and the Da Costa coagulating plant of David Bridge, are fast enabling rubbers from all centres—Castilloa in Mexico, Ceará in Brazil, East Africa, &c., or Landolphias, Ficus, Funtumia, and other African varieties, to be turned out equal to fine hard Pará or the Eastern kinds. The Da Costa system of smoking enables the planter to turn out

smoked rubber equal to Pará, with the swiftness, facility, and low cost of the Eastern rubbers. The Pfleiderer washer may also leave its mark in the rubber world for this reason. Coagulation in the future will be done more and more in bulk; this has already caused the Da Costa machine to be much used, especially as it is but part of a complete labour-saving plant. With the Pfleiderer or a similar washing machine, we believe that it could be arranged that the coagulation could be done in the receptacle, possibly by means of coagulants like the Purub or Elias patents, and then the liquor drained away, and the rollers set in motion to wash the now coagulated rubber without having to remove it. Such a process would save time and labour, and ensure greater cleanliness. I have always been a great advocate for the vacuum dryer; in my journal *Tropical Life* I was the first to call attention to the advantages of such a system *in skilful hands.* Except with the rotary dryer that I designed for mixed estates, cacao, coffee, coco-nuts, &c., no other dryer can be used for one and all products, even including rubber, like a vacuum dryer can.

At the utmost you need only change the trays, and that even is not always necessary.

In Jamaica, the planter already referred to as being troubled with sour soil and diseased cacao trees, the one encouraging, if not actually causing, the other, also expressed himself as being "rather sick of the fight with pests and plagues of all sorts--brown-rot, canker, scale, vermin, &c." Some friends at West Bromwich sent out fluids to get rid of the pests, whilst the first consignment of the cacao fertilizer proved so efficacious that a second lot of 5 tons was ordered, and has just been shipped. The report on the first lot was as follows: "I consider that after the careful experiments made with the cacao fertilizer, which I got out on your recommendation, it has satisfied my expectations. As far as I am able to note results, the effect of its application has been to minimize the loss of pods which would otherwise have failed to arrive at maturity on so many of the trees."

It has been proved, therefore, with rubber and cacao trees, that both direct and indirect benefits are obtainable by the use of suitable manures. The yield or crop is increased, the

tree invigorated, and pests discouraged. I hope, therefore, that tropical agriculturists generally will carry out experiments with the various manures, fungicides, and insecticides, to see if the pests, that rubber and cacao estates now seem so liable to, cannot be prevented from becoming really serious.

Drying Rubber previous to Shipping it from an Estate in Bolivia.

PROTECTIVE BELTS.

WITH respect to protective belts, Mr. John Parkin also wrote on this in the admirable article on the "Science and Practice of Rubber Cultivation" that he contributed to the January (1910) issue of *Science Progress*, when he said: "A large uninterrupted area occupied by a single species of plant offers a most suitable field for the spread of a fungus or an insect foe. There is nothing to check a disease commencing at one point from spreading rapidly over the whole plantation; consequently a system of blocks, separated from one another by screens composed of other trees, is recommended for rubber estates. A disease or pest observed in one block might then be overcome before it had time to penetrate to a neighbouring area.

"These protective belts may be formed by the retention of strips of the virgin forest, or they may be planted specially. If the latter course be adopted, trees of economic importance should, if possible, be chosen, care being taken not to

select any nearly related to that composing the main cultivation. For example, Castilloa or Ficus might be used in connection with Hevea, thus affording extra quantities of caoutchouc; or trees used for supplying timber for the estates might be planted. Manihot would not be advisable, as it not only belongs to the same family, the Euphorbiaceæ, but also the same tribe. Fungi and insects often confine themselves to nearly related groups of species."

The late J. B. Carruthers, when in Trinidad (W.I.), was, I am glad to say, of the same opinion as myself with regard to the methods to be employed when planting more than one crop. In the *Trinidad Bulletin* he strongly advises the planting of rubber by itself on the land, and not in conjunction with other trees.

If my memory is not playing me false, the idea of wind belts was specially brought forward at the Ceylon Exhibition of 1906.

I believe cotton under coco-nuts, especially on irrigated land, would form a good protective belt. Cotton will not thrive on the usual run of rubber lands, these being too damp. Stockdale reports that coco-nuts are used in Malaya as

protective wind belts for rubber on the coastal lands. In Trinidad (W.I.), Mr. Frank Evans reports that on several cacao estates recently formed in that Island, protective belts of virgin forest have been left. This, of course, is not always possible, and where belts have to be planted it would be well to make use of such useful timber-producing trees as cedar (*Cedrela odorata*) or Honduras mahogany. These would not only protect the main crop, but in time to come would prove a valuable source of revenue to the planter.

"We have repeatedly drawn attention," writes the editor of the *Journal of the Jamaica Agricultural Society*, "to the necessity of planting useful trees on estates where the trees of most utility have been cleared off. This is not an expensive operation here where native lumber trees propagate themselves so readily. We have especially called attention, however, to the economic value of eucalyptus trees, a value so largely recognized now outside of their native home — Australia. Eucalyptus trees grow quickly, provide hard-grained wood, fit for nearly all purposes, their blossoms provide nectar for bees, their leaves provide

oil, and they are healthy trees to have on an estate.[1]

"We published an article in the May Journal from the *Hawaiian Forester*, showing what was being done in Hawaii, and the excellent results attained in a limited number of years from the planting of eucalyptus.

"We would call attention to the letter published under 'Correspondence' in our June Journal, which is from a member of the Society in Cuba, where he is in charge of a very large plantation. There, besides other extensive agricultural operations, they are planting 100 acres of eucalyptus trees.

"Our correspondent says: 'I should have thought eucalyptus the best trees to plant in the city of Kingston, as they grow straight, will not require constant lopping, and do not shed a litter of leaves that will require much cleaning, while they are continual and inexpensive sanitary officers, providing natural drainage, and filling the earth and air with antiseptic and pleasant odours.'

[1] I am told the trees do not do well on the plains, only on the hills.

"*Eucalyptus globulus*, however, is not supposed to grow well; in fact, I believe it will not grow at all in the hot lowlands; but there are other varieties equally useful, which will grow in the hottest and driest places. Again, eucalypti do not throw any shade.

"While here, we are glad to note all about the country. A few large planters are allowing woodlands to come up again on their back lands, and in some places even on roadside lands where it is rocky. We also note that these new woodlands are full of young lumber trees, still this policy is not general. Most proprietors prefer to rent such lands for the sake of the present penny. We have heard it said that those proprietors who will not rent their lands, but allow them to grow up in woodlands, are selfish and acting against the interests of the country. On the contrary, we recognize in them benefactors to the country, whether they are intentionally so or are conscious of doing good or not. Their motives may not always be to grow trees for future use as lumber or firewood, or to grow woodland for the sake of the rainfall, or for conserving the fertility of the soil for future use; but no matter what motives they

have they are rendering a public service, and we should like to see more proprietors doing the same.

"There are many varieties of the eucalypti; blue-gum is the *Eucalyptus globulus*, from the leaves of which the oil of eucalyptus is distilled. This oil is a powerful antiseptic and deodorizer, a febrifuge and anti-asthmatic and anti-spasmodic. Its use in influenza and cold is well known. Infusions, decoctions, and even cigarettes are made from the leaves.

"The blue-gum is said to have excellent sanitary effects when planted in malarious districts, such as the Roman Campagna—parts of which have been already reclaimed by its use. This result is brought about partly by the drainage of soil (the trees absorbing great quantities of moisture), and partly by the balsamic odour given out, which the mosquito dislikes. It would surely be a valuable investment to plant these trees in swampy waste[1] lands, especially near seaports and railways. And lands now lying idle and useless might be made into valuable assets for posterity—especially in a country which is gradually, I

[1] Hart says they will not grow in such places.

may say rapidly, being denuded of its fine valuable timbers—and little or no re-afforesting being done."

Leaflet No. 1 of the Agricultural and Forestry Department, Nyasaland, under the heading of "Some Notes on Tree Planting in the Shiré Highlands of Nyasaland," gives particulars of the various eucalyptus trees, and the uses that their timber is most adaptable for. Of the following, we are told all but two yield valuable timber, the exceptions being *E. robusta* and *E. Smithii*. The list given consists of *E. affinis*, *E. acmenoides*, *E. citriodora*, *E. longifolia*, *E. maculata*, *E. paniculata*, *E. pilularis*, *E. punctata*, *E. rostrata*, *E. rudis*, *E. saligna*, *E. sideroxylon*, *E. tereticornis*, with *E. robusta* and *E. Smithii* making fifteen kinds in all. The details of each kind are also given in the *Agricultural News*, Barbados, of May 28, 1910. The *E. robusta*, or swamp mahogany, is stated to only grow well in moist soil or drained swamps. It may be planted for the purpose of drying up swamps. The timber, however, is of little value. *E. Smithii* yields a very good oil, and is a slow grower. It is only suitable for ornamental and shelter planting.

RUBBER IN BOLIVIA.

Llamas, sometimes used in the Dry Season for transporting Rubber from the Interior to Sorata.

Hart maintains, and with reason, that planters are far too prone to go to outside centres for their trees, and so needlessly pile up their expenses. Many suitable trees which grow close at hand are often passed over; and yet these would serve equally well as the foreigner to dry up the swamp, and at much less cost.

Mr. Carruthers, in his report issued from the Federated Malay States in 1905, touched upon the matter of protective jungle belts. Prof. Harrison and Mr. Stockdale, in Section 12 of Rubber Experiments summary in the Progress Report for the Department of Science and Agriculture, British Guiana, for 1909, state as follows: "The detrimental effect that constant winds have on both hevea and sapium trees indicate that in laying out plantations, cultivators should lay them out in sections *with good protective forest belts* in between the different sections, and on no occasion should the tops of the hills be left bare. A well laid-out plantation should have protective belts, as windbreaks, in order to keep winds out of the cultivation. This policy is also most desirable from a plant sanitation point of view."

"Scale insects," we are told in the last report from British Guiana, "affect *Sapium* to some extent, but they can be controlled by spraying with suitable insecticides. This liability to scale should induce cultivators of this tree to plant in 50 to 100-acre sections with good forest belts between the different sections."

The *Natal Agricultural Journal* for March, 1910, had a very striking article on the evils resulting from: (1) Soil erosion; (2) soil deterioration, and quotes descriptions of the African veldt in 1783, when it was difficult to see the game on account of the rich grasses and shrubs that extended over country, which to-day is described as being a grass-denuded veldt. The gradual impoverishment, detrition, and denudation of the soil was brought about only by the almost criminal neglect of the farmers and stock-raisers, who took no trouble to prevent the rich surface soil, manured by decomposed vegetation, from being swept away by the torrents from the land, where it was badly needed, down to the rivers and water-courses, where it was harmful. The whole article is well worthy the attention of all

agriculturists, for it treats of the two matters of soil erosion and soil exhaustion in full. It starts with the following quotation from James J. Hill's speech on soil deterioration in Carolina, before the Conference of Governors of the United States in May, 1908, when he said: "North Carolina was, a century ago, one of the greatest agricultural States of the country, and one of the wealthiest. To-day, as you ride through the South, you see everywhere land gullied by torrential rains, red and yellow clayey banks exposed where once wĕre fertile fields, and agriculture reduced because its main support has been washed away. Millions of acres, in places to the extent of one-tenth of the entire arable area, have been so injured that no industry and no care can restore it." I know many spots in the Tropics that are suffering from the same neglect of soil erosion. Reservation of forest belts would surely go a long way to remedy such evils.

Contour drains are of course invaluable to prevent loss of soil. Stockdale mentions a striking example in this respect, as follows: "A planter who on my advice had tried contour draining, said they were no use as they filled

up so rapidly." What an excellent object-lesson of their utility; where would this soil have been had it not been kept back by the drains. In spite of this, the planter seemed unable to realize that what he complained of was to his advantage. The habit of planting squares of closely sown, low-growing leguminous plants, as practised with young coffee on the slopes of the hills in Java, is also recommended by Mr. Stockdale.

The Hon. D. S. DeFreitas, of Grenada, in May, 1908, spoke of the "Indiscriminate Destruction of Trees," which, he said, was doing considerable damage. He cited the "Valenciennes" estate as an example of the result of the reckless destruction of trees. The falling off in the yield of cocoa on the "Chadeau" estate could, he said, be distinctly traced to the same cause. Trees were the buildings of God, and were grown for a wise purpose, and it was very much to be deplored that, for the sake of a few bags of charcoal, the ridges and hillsides were being denuded of trees. Unless something was done, and done very soon, there was no knowing what might happen. He cited the dependency of Carriacou as an example of the

unwisdom of destroying trees. We may soon be in the same plight unless the practice of felling trees, particularly on the ridges and high lands, is arrested.

Mr. Branch, at Grenada, found on some estates in the island that a great loss of vegetable matter took place in those fields with heavy slopes. The leaves from trees in such localities generally find their way to the bottom of the ravines, unless precautions are taken against this. Deposits of 5 and 6 ft. were to be seen. "As the weather was exceptionally dry," he reports, "I advised the owners to take the excellent opportunity, before these deposits were washed away, of bedding them into the surrounding lands."

Writing on June 19, 1902, on the "Deforestation of Mountain Ridges," (Trinidad Agricultural Society, Council Paper 69, 1903), Mr. C. S. Rogers, Forest Officer, stated that he advised, on the question of legislation, to protect mountain ridges in general and for the protection of the forests on hills, in order to conserve and improve the water supply. Several important Crown Land Reserves have since been laid out in various parts of the

Colony with an advantage to the neighbouring cultivation which is already evident. In a paper by Mr. F. E. Kanthack, A.M.Inst.C.E., Director of Irrigation, Cape Colony, it is stated "that in all parts of the world, civilized countries are now coming to appreciate the urgent and immediate necessity for preventing further destruction of forest growth and for re-afforesting destroyed areas. This is especially noticeable in the great irrigating countries, America, India, and others, such as France,[1] &c., where the effect of ruthless destruction of forest growth is becoming more obvious every year, and sufferers are realizing the true causes. Man is everywhere the origin of the trouble. In his utterly selfish and unreasonable claim to absolute individual freedom to do as he wills with the resources of Nature, he has by burning, felling, lopping, barking, over-grazing, or other mal-

---

[1] Forest belts also *equalize* water supplies. Had deforestation not been carried on, on so heavy a scale in France, the land would have had the benefit of the moisture, instead of the lack of forests causing it to swell the rivers, and flood out Paris and other centres, thereby doing enormous harm in the towns and cities, instead of benefiting the crops in the country.

treatment of the forest, himself denuded the hillsides of their growth and their soil. He has caused the once perennial springs to dry up and has partly buried good fertile soil in the plains below, beneath masses of useless sand and gravel. He has caused unthinkable quantities of rich alluvium to be carried away to the sea, and originated the disastrous floods which now cause such terrible destruction to life and "property."

Fortunately for Trinidad, the matter has been taken in hand before the consequences of neglect have become so serious as in many places elsewhere, but the warning of the diminished water supply of Diego Martin, St. Ann's and Maraval should not be forgotten. It is not so many years since people were regularly bathing in the Maraval river some distance below the reservoir, where nothing is now seen, except in times of flood, but a dry gravel river-bed. But in spite of warning, one may still see the hill ridges in many places being denuded of their forest cover, and this not so much in the far away districts as before our eyes. Patches are being cleared to the very ridge of the hills around the Savannah at Port-of-Spain, and the

same defiance of Nature's teaching is only too evident in the Santa Cruz and other adjacent valleys. In the report of Mr. Rogers, referred to, he goes fully into the subject and indicates remedial measures, which whilst beneficial to the community, would not interfere unduly with the property or rights of the individual. In addition, therefore, to the salutary provision of Crown Land Reservation, the question of maintaining public reserves on private hill lands on equitable terms is one that is probably worth the further attention of the authorities.

I am not alone in urging the importance of conserving forest belts on the West Coast of Africa if that part of the Empire is to turn out the heavy shipments of cacao, cotton, rubber, palm-oil, &c., that we hope to receive from there in return for our machinery and manufactured goods. I have much pleasure in reprinting what the *African Mail* said in their issue of February 4 (1910) on the importance to the cacao industry of preserving forest belts.

It is difficult, we are told, to exaggerate the importance of the report on the Gold Coast forests by Mr. H. N. Thompson, Conservator of Forests in Southern Nigeria, which

has just been issued by the Colonial Office. It represents a very monument of labour by an official whose experience and knowledge of the subject are probably unrivalled, and it demands, and will receive, the most earnest consideration at the hands not of the Gold Coast Administration only, but of all the West African Governments and of the Home authorities. The Gold Coast cacao industry is a native enterprise which has rightly been regarded as one of the most promising features of recent industrial development in West Africa. It has become, in some respects, the leading industry of the Gold Coast. It would be disastrous, not only from an economic but from a social point of view, if the industry became adversely affected. In this respect Mr. Thompson's Report is really alarming. The cultivation of cacao requires moisture as a necessity of its existence. If the natural moisture-containing and generating forces in a tropical region suitable to cacao cultivation are removed, the industry must, in time, collapse. In other words, if there be a too great denudation of the forests in the neighbourhood of cacao plantations, the result must be to kill

the industry. And this, Mr. Thompson tells us, is precisely what is taking place in the Aburi district, the centre of the Gold Coast cacao industry. The land is being cleared so rapidly of forest trees, principally for farming purposes, that the process of destruction may even be said to have begun. The water supply is decreasing, the vegetation is changing, the denudation of the soil on the hillsides is steadily increasing. "Under existing agricultural practice," says Mr. Thompson, "there is nothing whatever to stop the gradual spread of the arid country into the very heart of the forest region, and that is what will undoubtedly take place unless efficient barriers against its spread are created." And he adds: "As matters now stand, there is every indication that the cacao plantations on the hills facing the plain are doomed to destruction at an early date. The vegetation here is already altering in character from the evergreen to the deciduous type, and the change is so pronounced that the Acting Director of Agriculture estimates the life of a cacao tree at not more than six or seven years in this locality. What is more important, however, is that the

damage is not likely to end here. The process of substitution will progress till the very heart of the forest country is involved. Such changes will jeopardize the palm oil industry as well as bring about a general reduction in the fertility of the soil."

With the Sahara Desert further north as a warning, no one who is anxious for, or interested in the agricultural industries on the West Coast of Africa can afford to ignore their warnings.

RUBBER IN BOLIVIA.

Manager and Assistant Manager, Boston and Bolivia Rubber Co., with Three Tons of Rubber at an Outpost of Chimiri, for shipment.

STUMP-PULLING.

The above word, stump-pulling or stump-grubbing, is an ominous one to most planters; although no one can deny the great advantages of getting rid of old tree stumps on tropical estates, all agree with equal unanimity that the process is a somewhat costly one. Formerly it was much more so. To-day it is somewhat cheaper.

It is difficult, however, to give the accurate cost of clearing the land of tree stumps at different centres, owing to the difference in the skill of the men operating the machine, as well as to the class of extractor used.

As a general rule inexperienced and unskilled labouring men are used on this class of work. Very often it is the cheapest class of labour that is employed, usually with one man as the foreman who has good judgment in the handling of this class of work.

The men very soon, however, get accus-

tomed to the work, and learn to understand the machine, and the proper method of making the hitches and taking all the advantages wherever offered, so that the amount of work done is surprising.

Mr. Rufus King, of West Chester, Iowa, in the United States, has been pulling stumps with a triple-power steel machine, using three men with a team of horses and the machine, and working every day for six months to pull hardwood stumps, oak and hickory, varying in size from 6 in. in diameter up to 3 ft. He reports that five minutes is the longest time ever required to pull one stump, and usually about three minutes is the time required.

In the yellow pine regions of the southern portion of the United States these triple-power steel machines are being used very extensively, the No. 3 size being used principally on the large timber from 1 ft. to 4 ft. in diameter. In many places, with a gang of four men and two horses, twenty to thirty stumps an hour are extracted, or between two hundred and three hundred stumps per day, no labour being employed other than the four men and the two horses. Trees and stumps

running as large as 7 ft. in diameter are pulled out in a very few minutes with a No. 3 Extra Large Size Triple Power Steel Puller.

The soil in the regions where this large timber grows is usually loose, and the subsoil is more or less of a gravel nature, which makes the pulling of these large trees easier than the hardwood trees in the heavy clay soil. The stumps and trees pull easier in wet regions and during wet seasons of the year when the ground is soft and moist than during dry times.

The most popular method of doing the work is to use a machine with 200 ft. of a good, strong, steel wire cable attached to the drum, the machine in turn being anchored or fastened to a convenient stump; the hardest stump to pull is generally used for this purpose. A loop formed of the strong steel cable is dropped over the anchor stump, which holds the machine in place.

The steel cable is drawn off from the drum and fastened to the stump to be pulled. A team of horses or oxen then wind up the cable on the drum, the leverage giving them extraordinary power.

By this method stumps are pulled 200 ft. away from the machine in any direction, thus clearing an area 400 ft. in diameter at one setting of the machine, or practically three acres without moving.

Where the men are experienced in the work, using four men and the horses or oxen, and where there is not too much brush on the ground to interfere with the work, a force of four men and the horses can clear all the land within reach of one of these machines in one day, approximately three acres.

By a system of movable pulleys, similar to the tackle block, the triple-power machines triple the power of the wire cable, and also of the horses or oxen, developing an enormous strain, even as much as 400,000 lb., with two horses on the sweep.

This great increase in power is secured largely through the assistance of the movable pulleys.

Another expert claims that with the right machine the stumps can be extracted at the rate of 100 to 250 a day with two reliable men, assisted by a good team of horses and a driver who knows his share of the work. On

account of the increased facilities obtainable for this portion of the work of planting-up new lands, the shipments of reliable stump-pullers to tropical and sub-tropical countries have been multiplied many times over during the last three or four years.

In Cochin-China the planters are quite alive to the advantages of extracting the stumps. They use an extractor which is worked by six men, and removes from twenty to thirty stumps of different sizes in a day.

As shown earlier in this book, I have always advocated the removal of stumps, if possible, when clearing lands in the Tropics. Mr. Rudolph Anstead, Scientific Officer at Bangalore, Southern India, is also of my opinion, and recommends the use of monkey-jacks for removing the roots. In the November (1909) issue of *The Planters' Chronicle*, he writes :—

TREE STUMPS AND ROOT FUNGUS.

"In the report of the Government Mycologist for the Federated Malay States for 1907, it is stated that the greater number of inquiries from planters in respect to diseases of rubber, referred to the root disease caused by a fungus

which spreads from some of the old jungle stumps, among the rubber trees, to the healthy young plants of fifteen to thirty months old. It is also reported that the fungus has on several occasions been traced from an old stump in the nursery to young plants in its neighbourhood.

"Whenever forest land is cleared and crops such as coffee, tea, and rubber, are planted up in Southern India, trouble is usually experienced, sooner or later, from the dying-out of the plants near certain old stumps, while certain shade trees, if killed or felled, are known to cause the death of the surrounding plants of the staple crop.

"Trees that generate root disease should not be planted in new cultivations as shade, and when it is necessary to remove such for any reason from old cultivations, care should be taken to burn the stumps and remove and destroy as many of the roots as possible.

"The trouble is caused by one or more fungi, of which *Rosellinia* is well known to tea-planters. The soil contains the spores of these fungi. The spores themselves are incapable of germinating on, or growing in, living

root tissue; when, however, decayed roots are present, owing to the death of a tree, the spores can, and do, germinate on the decayed matter, and they then produce a mycelium which has the power of passing on to, and growing on, living roots. This mycelium creeps through the ground from root to root, and plant to plant, of the staple crop, destroying them in an ever-widening circle.

"The symptoms of the disease are well known to most planters. A plant will one day show signs of bad health, the leaves gradually wither, turn brown, and fall off, while the plant shows no other sign of disease on the leaves or shoots. The shoots rapidly follow the leaves, and finally the whole plant dies from the top downwards, the complete process often taking place very rapidly. Plants in the neighbourhood then follow suit as the disease spreads.

"When a dead plant is dug up the main roots are found to be rotten, while, round the collar and below it, is a black charcoal-like mass, cementing earth and stones to the plant.

"In some districts in Mysore I was shown a root disease of coffee, which causes similar outward symptoms, but takes much longer to

kill the tree outright, sometimes as much as twelve years. All the while the trees look 'shuck' and sickly, and never respond to any manurial treatment as they should. These plants when dug up do not exhibit the charcoal appearance, but instead have round the collar, and on the main roots, a black bruised appearance, covering larger or smaller patches, the cambium and bark being rotten and slimy over these patches. In the final stages the tap root is found to have rotted.

"It is quite possible that this may be due to a different fungus from the last, though a similar one, but it is impossible from merely field examination to say whether this is the case or not. A great many things point to the probability that the fungi are identical, but in different stages of their existence. As far as I could ascertain, this form of the disease always begins as the first form, which has been neglected and has spread over a large area. Possibly the fungus, by growing on from plant to plant over a series of years in a purely vegetative way, has grown weaker, and so takes longer to kill. This is only a conjecture, and nothing definite can be said on the point

until a comparison has been made between the two forms in the laboratory. From the practical planter's point of view, however, it is immaterial whether the two fungi are identical or not, as the preventative methods to be adopted are the same in both cases.

"From the nature of the disease a cure is almost impossible once the plant is attacked, and it is often difficult to detect the attack until the mischief is done. Efforts should be concentrated upon preventing the spread of the disease, as soon as its presence in any given spot is detected. Diseased patches should be isolated by digging a trench round them deep enough to get below the root area, and the excavated soil, which may contain fungus, must be thrown into the isolated area and not outside it. The trench should be dug completely round the diseased patch, and enclose a fair-sized area around the centre of infection to ensure getting beyond the range of the fungus mycelium. Care should also be taken to prevent the fungus being carried to uninfected areas on tools, coolies' feet and clothes, &c.

"Forest and shade trees known to initiate the disease should, if they must be removed, or are

likely to die, be *completely* surrounded by a trench, as described in the case of the diseased patches, while plants which have died from the disease should be dug out and *burned*, to prevent the fungus producing spores which will be carried about by wind and water, and spread the disease outside the isolated areas, which will happen if the dead stumps are left lying on the ground. Wherever it is possible tree stumps should be dug out and burned. For this work probably some form of monkey-jack will be found both useful and labour-saving.

"Good drainage is also essential," Mr. Anstead tells us, "as stagnant water in the soil encourages the growth of the fungus.

"The use of fungicides has in some cases given good results. Lime applied generously in an unslacked form, is nearly always efficacious, and it should be used on patches where trees have died of the disease, and been removed.

"Ferrous sulphate also, broadcasted and lightly pricked in at a season of gentle rains, so that it can percolate slowly through the soil and bathe the roots, has in some places given excellent results, especially when used at the beginning of an attack.

"Experiments have been arranged on a number of totes with this fungicide, especially in connection with the slower form of the disease described above. Results will be published in *The Planters' Chronicle* as soon as they are obtained. The fungicide is quite cheap, and can be obtained at about Rs.72 per ton, and an application of six to eight ounces per tree should be broadcasted.

"After a plant has died of root fungus it should not be immediately replaced, or the supply will probably be attacked. It should be dug out and burned on the spot, with as many roots as possible, quicklime or ferrous sulphate freely applied, and the patch deeply forked up and left with as much surface exposed to the air as possible (by heaping) for a year before planting a new supply.

"Finally, great care should be taken about nurseries, and no stumps or dead roots should be allowed to remain in them. Any young plants put out from a nursery infected with root disease will not only die, but form a centre from which the disease spreads. In land known to be infected with the disease, it may possibly be found a good plan to soak

the roots of the young supplies in Bordeaux mixture before they are planted out."

A firm which has had, I believe, considerable experience in forestry work, and whose opinion I have no hesitation in accepting when it is a question of clearing the land of trees for cultivation, wrote as follows in answer to my queries *re* the probable cost of stump-grubbing in the Tropics as compared with similar work being done on the Continent:—

"There can be no doubt that, if rubber and other companies want to have their estates free of disease, it is absolutely necessary to grub up the roots and stumps of the forest trees and shrubs, and then have the fields well ploughed.

"The kind of plough most suitable depends, of course, on the nature of the soil, but we would suggest three, four, or five-furrow ploughs, entirely made of wrought steel.

"The principal implements, however, for any planter, who has to effectively clear a large area of forest land for planting purposes, are tree-stumping machines.

"There has lately been placed upon the market hand tree-stumping machines, at a cost of either £19 5s. or £24 10s. each. These

are most effective implements, and with them experienced men will extract 100 stumps of the smaller trees, say up to 20 in. in diameter, as an average day's work. The machines are easily worked, and men soon become experts in using them. Three men are required to work the machine, and a fourth to lay the tap or main roots bare.

"If it is intended to employ animals, such as oxen, mules, or horses, a tree-stumping machine like the 'Forest Devil' should be used. With them it is possible to pull out complete trees, together with their roots, or else large stumps, and even to remove large stones, or to transport small houses or barns.

"These machines are made in six sizes, requiring one or two animals, and range in price from £16 5s. to £90 each.

"To illustrate the effectiveness of such machines we include the report of work done, together with the cost, by an important forestry department abroad, viz.:—

"We used the 'Forest Devil' stumping machines, and have pulled, in nineteen working days of ten hours each, 630 pine tree stumps of from about 16 to 30 in. diameter. We employed

two horses, one driver, and six men, and used one machine each of No. 4 (price £35 15s.), No. 6 (price £44), No. 7 (price £90). The stumps had particularly deep and wide spreading roots. The soil was stony above and underlaid with clay. The expenses of pulling, clearing, and sawing up of 630 stumps, including the filling up of stump holes in the soil, work out at £54 4s. The area cleared was 300 acres. The stumps yielded about 1,350 cubic feet of firewood. The results are most satisfactory, especially if, as here, the cleared area has to be ploughed over, for the use of these machines loosens the soil most effectively."

The Australian Monkey-jacks, I understand, are coming into general use on plantation and forest work in all parts of the world. These jacks are said to be the result of half a lifetime devoted by the patentees to the design and manufacture of implements for saving time and labour in the stump, root, and stone grubbing, and the general heavy work involved in clearing forest land, when adapting it for general agricultural purposes.

They are light, portable, easily operated and can be carried to, and used in, very awkward,

and almost inaccessible places. Costing from £3 10s. to £6 10s. complete, they are not expensive. There are three types of these Jacks, viz., model C B for lifts of 4 tons (this is a light, strong, and durable implement, being specially designed for contractors' work, log rolling, timber handling, and light clearing work. The spear, a light, detachable extension piece, is especially useful for lifting poles or posts out of the ground, and also in erecting same, as well as for many other purposes). Model D, with an 8-ton lift (this, while doing all that the C B will do, is intended for a heavier class of clearing and grubbing work; the gear is of the simplest, and all parts are interchangeable; the handle supplied with this jack is made of extra rigid steel, and is so designed that it can also be used as a crowbar, a necessary tool where grubbing operations are being carried on). Model C A, having a capacity of 10 tons, is designed for the heaviest grubbing and stumping work, and has a longer lift than any other jack of its weight and power. This jack, as well as the model D, is provided with two detachable spears of different lengths to suit the work in

hand. These lifts are able to obtain a grip high up on a tree, which greatly increases the leverage obtained, and allows the base of the jack to be placed back well clear of the roots. The lifting claws of these jacks are specially designed for grappling stumps, roots, and logs.

Much discussion has of late appeared in various magazines, bringing to light the result of various experiments made as to the danger of fungus and other diseases spreading from old decaying roots and stumps to newly planted trees in the vicinity.

From the report of the North Borneo State Rubber Co., Limited, we see that the late Mr. W. C. Cowie, who presided, stated that the planted area was about 1,000 acres, representing some 168,250 trees. The manager had reported that there were a few cases of root disease, and, acting on his advice and on that of the visiting agent, the directors had recently decided to stop all further extensions *until the whole of the planted area had been dug to a depth of 18 in. and the old jungle roots taken out and burnt.* The rainfall for the year was 130·97 in., which caused incessant attention

in keeping the weeds down. As they could imagine, the rubber trees were trying to keep pace with the weeds, and, consequently, the 225 acres planted during the latter end of 1908 should be ready for tapping in about two years' time. Here, therefore, is at least one company who believes as I do, viz., that if root trouble appears when planting up new lands, the only remedy is deep cultivation and the removal of all the old stumps and roots.

Considerable areas of forest land are being taken up and cleared for cultivation throughout the tropical and sub-tropical zones, and cultivators must remember that the stumps of trees that have been felled may constitute a danger to the cultivation if not removed.

An official at the Queensland Agricultural College, Gatton, in reporting on some "Australian Monkey-jack" trials, said :—

"With regard to the trial held at the College, the stumps extracted varied in diameter from 12 in. to 18 in., and the strongest were uprooted in five minutes by the aid of one man. One of those present informed the party that he had stumped seventeen acres in less than seven days."

Elsewhere it has been reported that, "In ten minutes from the time of starting, a stump 2 ft. across was laid on its broadside, and the buyer claims that the jack repaid its cost in a fortnight."

"The jack is a very useful appliance, practical and handy, and is quite capable of rooting up trees from 1 to 2 ft. in diameter. A jack worked by two Javanese is capable of grubbing from seventy to eighty roots (or small stumps) per day. It is an easily worked and time-saving appliance."

MANURING CACAO.

GENERAL facts as regards manuring are that an unmanured plant is less resistant to disease than a judiciously manured one; plants receiving applications of a complete manure are most resistant; plants receiving sufficient phosphoric acid, potash, and nitrogen are more resistant than those which receive a heavy dressing of only one or two of these manures; applications of a manure containing the proper proportions of each, produce a vigorous growth which, however, can be overdone by an overdose of either kind. Generally speaking, an abundant supply of phosphoric acid and potash tends to increase fruitfulness, vigour, hardiness, and firmness of stems and leaves. Care must, however, be taken not to apply the nitrogen in too strong doses, as by so doing the trees can be over-stimulated and their vitality weakened. On this account dressings of nitrate should be applied in small doses and at more frequent intervals. As the function of potash in plant

RUBBER IN BOLIVIA.
Water Transportation of Rubber on Shallow Rivers; Boats in the Bolivian-Amazona districts.

physiology is largely connected with carbon assimilation, and the formation of the starches, sugars, and cellulose tissues, potash not only increases the quantity and quality of the yield (of cacao, rubber, or other crops), but helps to strengthen the woody parts of the producing plant, and therefore makes the trees or plants better able to resist the attacks of diseases and pests.

Mr. Rudolph Anstead, when in Grenada, strongly advocated lime as an excellent "fertilizer" to use on clay soils, especially such soils as they have in Grenada. "Though it does not act directly as manure in the sense that sulphate of ammonia does, for instance, it sets free plant foods from the soil by a chemical action, and also it immensely aids tillage operations, as it pulverizes the soil and forms, if properly applied, a fine surface tilth. It also aids drainage.

"It should be applied during the dry season before the rains come, and in the following way:—

"All the leaves should be raked up into heaps, and the soil surface cleaned of weeds, &c., but it is not necessary to fork. Then

broadcast slaked lime, at the rate of about 1 to 2 tons per acre, taking care that the lime is as finely divided as possible, and evenly distributed.

"The finer it is the better it will go in, lumps remain on the surface and are acted on by the air and rain and rapidly become useless. In fact, I believe that it would pay to grind the lime finely before it is slaked for agricultural purposes. Stockdale considers quicklime to be more beneficial than slaked lime if applied in small doses. When used it should be hoed in. When it has been evenly spread all over the soil, the heaps of leaves and weeds should be scattered over it so as to completely cover it. The point is that it *must* be covered over to keep the air away from it. If there are not weeds and leaves enough for this purpose it must be *lightly* forked in. This is the correct way of applying lime to the soil, and when applied in this way it gives the best results.

"You must remember that lime acts chemically on all manures containing nitrogen, attacking the nitrogen and setting it free as ammonia, and so destroying it as far as plants are concerned. Consequently, in applying lime, care

must be taken never to mix it, in the soil or out, with any nitrogenous manure. It must not be applied to the soil within six months at least of pen manure, sheep manure, sulphate of ammonia, or nitrate of soda.

"In conclusion, let me repeat here, what I consider to be a good system of manuring for the majority of Grenada soils, viz.: First year, lime $1\frac{1}{2}$ tons to the acre. Second year, pen manure, as much as possible, well forked in. Third year, nothing but bedding in of weeds and leaves. Fourth year, nothing but bedding, unless owing to a dry season or other causes there should be a lack of foliage, when you can apply $1\frac{1}{2}$ cwt. sulphate of ammonia per acre. Fifth year, basic slag, at the rate of 4 cwt. per acre. Sixth year, lime again, and so on.

"This system on a small holding is easy to carry out. It means dividing the holding into five equal portions, and treating one portion with lime each year, one with pen manure, and so on, so that the system is carried on over five sections, each one year ahead of the other.

"Where it is easy to obtain, or where the

cacao is apt to suffer from drought, I advise you strongly to keep the soil covered all the time with a good thick mulch of greenstuff, —bush or grass—while the above system is being carried out. When you have to apply a manure, just rake up the mulch out of the way, and apply the manure and spread the mulch again.

"In mountain lands, I would advise also, instead of only basic slag, an application of basic slag and sulphate of potash, in the proportion of 8 to 1—at the rate of 9 cwt. per acre, an application which has been found to give very good results and to last for several years."

"There is no doubt whatever about the advantages to be obtained by manuring cacao in a systematic way; the only question which is left open is that of the best fertilizer for each particular soil and district. In this connection more attention should be paid to the use of the pod shells, which are too often wasted and allowed to lie about on the surface in heaps until they dry up or rot. These heaps form ideal breeding nurseries for fungi, especially those fungi which produce pod diseases, attract

cacao beetles, and hold water and serve as breeding places for mosquitoes.

"Not only is this system of leaving heaps of pod shells about the fields a most unsanitary one, but it is a wicked waste of manurial material. These shells contain in their green state as much as 0·16 per cent. of nitrogen, the most expensive of all fertilizing constituents to buy, 0·45 per cent. of potash, and 0·09 per cent. of phosphoric acid, all of which have been obtained from the soil, and which should be returned to the soil as soon as possible for the use of future crops. When mixed with leaves and rubbish, the shells can be cheaply made into a compost which is a most valuable manure. Such a compost, made on an estate in Trinidad, was analysed by Professor Carmody (*Proceedings Trinidad Agricultural Society*, May 9, 1905), and shown to contain 1·55 per cent. of potash, 0·15 per cent. of phosphoric acid, and 0·056 per cent. of nitrogen, being considerably above the value of pen manure, which has been shown again and again to be the most valuable of all fertilizers for cacao.

"The benefits to be obtained from manuring

cacao, or any other crop, are twofold. Firstly, the trees are put into good health and condition, and rendered strong to resist diseases, or if attacked to throw off the attack quickly. Too much stress cannot be laid upon this aspect of manuring. A vigorous plant is often immune to the attack of a disease which will attack a weak plant, and if attacked does not suffer to anything like the extent that a weak plant does. This was very strikingly brought out in Grenada in the case of attack by thrips. In looking through my field notes, I find that in almost every case where it is recorded that cacao was suffering from thrips it is also noted that the cultivation was neglected, and that no tillage or manuring had been done. I have seen cases of such neglected trees where every vestige of foliage had been destroyed by this pest, and every pod was a rusty brown. Cultivation and manuring at once removed the pest, especially good drainage and the use of basic fertilizers, and it was seldom that well-nourished trees were attacked at all, or if they were, the attack was very slight. So much was this the case that thrips on a well-cultivated estate were a negligible quantity.

"Secondly, the application of manures increases the yield of the crop, and so becomes a paying business. It simply resolves itself into a question of profit and loss; the manure costs so much, the increased crop produced by its application is worth so much, the difference, if in the right direction, is profit, and herein lies the point—*the difference is in the right direction!*

"Experiment after experiment at Botanic Stations and on estates have proved this, and it is unnecessary for me to quote them at any length. A few which were conducted under my own supervision in Grenada may prove of interest because they were carried out actually on estates, under estate management, and under estate conditions. A full account of them, with many others, will be found in the Annual Report of the Grenada Botanic Station for 1908-1909, and in the *West Indian Bulletin*, vol. ix., No. 2.

"Three typical manurial systems only will be quoted here. Cattle manure was found to give the best results, but it is difficult, often impossible, on account of the shortage of fodder in the dry season, to get enough of it to

manure a large estate, so that minerals, backed with sheep manure, which could be imported, had to be substituted.

Manure	Annual gain per acre over no manure in pounds of cured cacao	Value per acre of increase over no manure; cacao valued at 6d. per lb.
A dressing of cattle manure once in two years	400 lb.	£10 0 0
2 cwt. per acre sulphate of potash one year; 4 cwt. per acre basic slag the next year	390 lb.	£9 15 0
1½ cwt. per acre sulphate of potash one year; sheep manure the next year; no manure the third year	352 lb.	£8 16 0

"The most remarkable results were, however, obtained in Dominica with the use of a mulch. This mulch consisted of the sweepings of the lawns at the Botanic Station, and proved to be better than any other form of manure. The average results of a five-year test were as follows (*West Indian Bulletin*, vol. ix., No. 2):—

Annual gain per acre over no manure in pounds of cured cacao	Value per acre of increase over no manure; cacao taken at 6d. per lb.	Cost of manure per acre	*Gain per acre by manuring*
648 lb.	£16 4 0	£3 0 0	£13 4 0

"It will be noted that in all these examples the value of cacao has been purposely put at a very low figure—6d. per lb. In the last case the difficulty in practice is to find enough material to mulch the whole of a large estate, but use can be made of material cut from surrounding waste lands, and, better still, the mulch can be grown among the cacao in the form of a leguminous green dressing crop, which just as it is about to flower can be cut down and spread on the surface as a mulch. This plan will also keep down weeds and their attendant expense.

"These few instances will be quite sufficient, without numerous others which might be quoted, to show the immense advantages to be obtained by systematic care for, and sanitation of, cacao orchards."

HYGIENE IN CACAO PLANTING.

One hears a good deal just now of the fungus diseases and insect pests of cacao, and there is no doubt that considerable losses have been sustained thereby. From many important centres, such as Trinidad, Surinam,

Ceylon, and St. Thomé, comes the same tale, in varying degrees, and quite recently we heard from the Gold Coast that the yield has been most adversely affected by serious diseases and pests.

THE MARQUIS DE VALLE-FLOR.
The Largest Cacao Proprietor in San Thomé.

Scientific men have been devoting much time and study to these subjects, and whilst, as a consequence of their investigations, many remedial measures have been adopted, one

cannot help thinking that the losses sustained might have been at least minimized had more attention been paid to the old proverb, "Prevention is better than cure."

It must not be supposed for one moment that I am suggesting less attention being paid to the cure—rather would I see it indefinitely extended since diseases and pests seem to be on the increase—but what seems to me to be essential, is that some comparatively simple methods of prevention should be adopted, by which the serious losses now being sustained may be considerably reduced, even if they cannot be altogether avoided.

It is to be feared that such initial precautions have been frequently overlooked in the past. It is certain that all trees and plants are liable to be attacked by disease and pests, and it is equally certain that the strong, healthy plant will more easily withstand the attack than the weakly, neglected one. It is impossible for this strength and vigour to be produced and retained unless great care and attention is devoted to the cultivation and management of the soil and to the proper feeding of the plant.

Is it not a fact that these ordinary precautions are too often neglected? And yet light and air and a proper system of feeding are just as essential to healthy young plant life as they are to children.

First of all, then, cultivate the soil, and see that it does not become packed, and so unable to absorb the rain-water and vegetable matter on the top of the soil. However good and rich a soil may be, it must be properly cultivated—nothing is of greater importance than this keeping of the soil porous; all your science and all your systematic feeding will be of no avail if this essential condition is neglected, not only in cacao plantations but all the world over.

Even this comparatively simple operation requires care, and haphazard stirring of the soil without due regard to the roots of the trees may easily do more harm than good. Common-sense and careful supervision are all that are needed in this instance, and that being given, science will assist in providing the next important element, viz., the feeding or manuring of the plant. The Island of Grenada is noted for the careful cultivation of her cacao

trees and the large yields obtained. Dr. Francis Watts, who succeeded Sir Daniel Morris a little time back as Imperial Commissioner of Agriculture for the West Indies, points out in the departmental handbook on Cacao Pests that "it has frequently been noted in Grenada that where a high standard of cultivation is maintained attacks of thrips and other insects are much less frequent, and little serious harm is occasioned." No greater incentive than this, to care for and supply the trees with adequate plant-food, could possibly be advanced.

Too many planters are apt to imagine that, given a rich soil, a cacao plant or tree will thrive for a long period practically without care and without manure; in fact, that once planted it will take care of itself. It may, of course, happen that in some cases there is a sufficient natural supply of plant-food in the soil to nourish the plants, but such cases are rare; and in *every* case where crops are removed, those crops take with them certain elements which must be replaced, whether it be nitrogen, phosphates, potash, lime, or other plant-food. It is to be presumed that the aim of every

planter is to produce a vigorous and healthy tree, which will not only be capable of yielding good crops, but strong enough to resist stoutly the attacks of diseases and pests. He must then, in addition to careful cultivation, see that there is present in the soil a sufficient quantity of the four main plant-foods before mentioned. In these days it is easy to supply these singly or together, as may be required; at the same time it is always advisable to use *some* farmyard manure if possible, for this is valuable not only for its manurial properties but for its mechanical action on the soil. Make a judicious use, then, of artificial manures, according to the requirements of the soil, in conjunction with half the quantity of farmyard manure which would have been applied had it been used exclusively.

An average gain of $2\frac{1}{2}$ bags (each $1\frac{1}{2}$ cwt. or rather over) per annum for three years has been obtained by Mr. W. M. Malins-Smith, in Grenada, owing to intensive cultivation and high-class manuring. This proves what I have all along maintained—that it pays, and pays well, to feed up and attend to the trees on cacao estates, and this is equally true with rubber, coco-nuts, &c.

Evidently Grenada as a whole has been doing the same as Mr. Malins-Smith, for in his letter he writes as follows: "We had torrents of rain in August, but September has given us fair and good weather. Crop prospects are splendid, and we ought to establish another record for 1910-11 on the top of the present one. This (the 1909-10 shipment) shows an increase of 6,000 bags over the previous best year, and is due entirely to intensive cultivation and high-class manuring, and we are bound to jump up again with the coming crop—1910-11—as during the last twelve months the imports of manure into the Island have exceeded those of any previous year. My experimental plots show the advantage of this. I have secured an increase of 7½ bags per acre during the last three crops over and above the no-manure plot, with only one application of manure. This has also left the trees in first-class bearing order. Going into details: The 'no-manure' plot gave, for three crops, 17½ bags cacao; my best manured plot gave, for three crops, 25 bags cacao. The cost of manure was only £5. Therefore, taking an average value of £4 per bag, a fair one in face of the past three years'

prices, I have made a clear net profit of £25 during the three years, on this plot alone, over and above my usual profit without manure. This is equal to £8 6s. 8d. extra profit per acre per annum by manuring."

I believe that for some years the area under cacao has not been increasing in Grenada to any appreciable extent. *The increase in the Island's exports, therefore,* has been due almost entirely to systematic cultivation and regular manuring on the lines that I laid down in 1900-1901, when I pointed out in my "Cacao Planting in the West Indies" (now out of print) how the Rev. G. W. Branch obtained 87 bags per annum from only twelve acres of land, part of twenty acres purchased for £100, so not of good quality soil. "My system of manuring," reported Mr. Branch, "caused the cacao trees to become surface-feeders, and provided I keep them supplied with food I shall have them well under control. I manure my trees by means of my donkey and cart, which goes along the roads made on the hill sides by turning the slope back to a level. Without manure the case is different; the tree has to push its tap root deeper and deeper every year in search of

food ; in doing so, it is inclined to strike 'tuff' or clay, and death ensues."

Here is an instance of the benefit of adequately cultivating and feeding up a small area at a low cost, instead of having to cultivate four or five times the acreage, at a much higher cost for labour, to get no larger returns, and in the end possessing trees more liable to disease and drought, and, in any case, depending on a larger number of labourers to be kept in order.

The Grenada cacao exports since 1900 have been as follows. As already stated, the increase is due mainly to the intensive cultivation, not so much to the increased area planted :—

Crop year, October 1 to September 30 :—

	Bags		Bags
1900 01	53,387	1905-06	54,381
1901-02	61,285	1906-07	60,087
1902 03	63,019	1907-08	64,379
1903-04	67,296	1908 09	67,343
1904-05	64,328	1909-10	73,865

Eminent authorities have laid it down that it should be the aim of the cultivator to grow and maintain on his trees as large a proportion of healthy leaves as they can carry, because it is in these that all the material necessary for the purposes of growth and reproduction is formed and distributed.

That being so, the first question which suggests itself is, what particular kind of plant-food will best encourage plants to make leaf? And it will be found that the nitrogenous manures have this effect. They encourage the plants to make leaf, stem and root, and they prolong the growth of leaf and stem, making the plant grow to a large size. After fruit is set they may then again be used to increase its size.

Such manure should, therefore, be of immense value during the first few years of a cacao plantation, more especially when it is desired to prevent the tree bearing too early, thus giving it greater strength and productive power later on.

The quickest acting of these nitrogenous manures is nitrate of soda. It should be applied in small quantities two or three times a year during the period of the most active growth, and it will be absorbed by the plant within three or four days. Little and often is a good maxim to remember in this case, three moderate applications being far more efficacious than one large dose.

It must not be imagined, however, that a

single constituent, such as nitrogen, will produce good results unless the soil is sufficiently supplied with the three other main plant-foods—viz., phosphates, potash, and lime. Phosphates encourage the fruit and act with nitrogen in creating sturdy plants and checking too rank a growth. Potash assists both in the early stages, and later when the fruit is setting; while lime not only helps the growth but improves the tilth of the soil, and causes the other constituents to be more readily taken up by the plants.

Another fruitful source of disease is lack of care in pruning. On this point we cannot do better than quote the words of Hinchley Hart, in his well-known book, "Cacao." It is there stated that the following are good maxims for the cultivator: "Prune little, but prune often. Prune carefully, but prune with decision. Prune for a large amount of healthy leaf surface, and a crop will come."

There are, of course, very many other points of great interest which might be touched on in connection with this subject, but my present object is merely to call attention to the necessity of doing all that can be done to *prevent*

disease; and since it cannot be doubted that the stronger the plant or tree is, the more capable it will be of resisting the ravages of both disease and pest, I can only urge the importance of producing such strength by thorough cultivation, judicious manuring, and careful and scientific pruning.

THE IMPORTANCE OF NITROGEN AS A PLANT FOOD.

Up to comparatively recent times many cultivators of the soil, whether planters, farmers, market gardeners, or fruit growers, held the opinion that scientific men could not teach them anything of value. On the other hand, the "man of books" had not fully realized the limitations under which he himself laboured, nor that he had much to learn from the practical man.

Within the last few years, however, the scientific and practical man have gradually come into closer contact with one another, and the attitudes of both have undergone a change.

It is now recognized by all who have given

RUBBER IN BOLIVIA.

The Manager of the Boston and Bolivia Rubber Co. going his Rounds.

any serious thought to the subject that all the world over, under the changed and keenly competitive conditions of the present day, education, scientific and technical, is essential to the success of any movement having for its object the improvement of the soil. However valuable the knowledge gained by practice may be, that knowledge must now be supplemented by scientific study. Supplemented, not superseded.

By this I do not wish it to be thought that the practical man must become a scientific expert, but to urge upon him the benefits he may reap by taking advantage of those invaluable discoveries of scientific men which have been proved by practical experiment and demonstration throughout the world to be beneficial to his crop and estate.

Each of these essential foods *must* be present in the soil, if the best results are to be obtained, and whereas either one or other of them is sometimes present in abundance, there may be a total absence of the others, which must be supplied in some form or another.

Of these three essential foods, the one which is most often lacking is nitrogen. It is also

the most expensive to supply, but its effect well repays the initial outlay.

The two best known purely nitrogenous manures are nitrate of soda and sulphate of ammonia. The latter is manufactured mainly from the ammoniacal products of gasworks, and is produced by the union of sulphuric acid with ammonia, which takes place immediately the two substances are brought into contact: but as, in that case, the nitrogen exists in the form of ammonia salts, it requires to be nitrified before it is available for growing plants. This process of nitrification takes place in the soil. Nitrate of soda, on the other hand, is the most rapidly acting of all fertilizers, and it is this characteristic which gives it such additional value, for it is certain that a small quantity of a quick-acting manure is more profitable than a large quantity of a slow-acting one, especially on soils which have become partially exhausted of the plant-food elements.

We sometimes hear it stated that an application of a nitrogenous fertilizer, such as nitrate of soda, has produced no good results. But in most of these cases where the use of nitrogen has apparently produced no effect, it

is due either to its having been carelessly applied, or to the absence of a sufficient quantity of one or other—perhaps both—of the other essentials, phosphates and potash. But as nitrate is so quick in its action, it is used generally during the early spring growth of plants and trees, and therefore almost always alone as a top dressing, the slow-acting fertilizers, such as phosphates and potash, having been applied after the removal of the previous crop.

It must be clearly understood that nitrogen is only *one* of the necessary plant-foods, and though it may be, and often is, beneficial by itself, yet it cannot supply the want of either phosphates or potash or other plant-foods which may be absent.

It must also be remembered that a sufficient quantity of nitrogen is an imperative necessity, and that most soils are deficient in it, certainly those which have been under cultivation for many years with the same crop. Great care must be exercised both as to the amount and method of application of nitrate of soda, and other soluble fertilizers. It is therefore necessary, while avoiding scientific discussions as

far as possible, as to their proper use, that those who apply them to their land should have a very clear conception of the underlying principles, in order that they may intelligently increase their production, and thus reap a profit. Having recently been much impressed with the wonderful results obtained by the use of nitrate of soda on maize crops, I took the opportunity of getting some information as to the proper use of that fertilizer, for, as I have said, a certain amount of intelligence must be exercised in its employment. It is necessary to emphasize this, because some very erroneous ideas are frequently entertained about the effects of artificial manures, which owe their origin not to any fault in the manure itself, but entirely to the fact that they have often been used in a very improper and unskilful manner. Even farmyard manure itself suffers more or less from the same causes, with the inevitable result that a smaller effect is produced on crops than if it were employed with greater skill and a more exact knowledge of the manner in which it acts on the crops to which it is applied.

In the case of the more concentrated and

costly artificial fertilizers the return is in a far higher degree dependent not on the intrinsic merits of the fertilizers themselves, but on the method of using them.

Of all these manures none requires to be employed with greater skill than nitrate of soda. None gives more disappointing results if improperly used, and none will give such a quick and ample return if it be employed in a proper manner.

There is no doubt that in many cases of insect pests the use of nitrate of soda may prove a most effective means of extirpation, as it forces the plant into such a strong and vigorous development that the attacks of the pests do not appear to have any serious lasting effects on the trees already attacked, and in cases where contagion is possible or probable, increasing the vigour of the tree is the best method of warding off the trouble. It is especially so with cacao, in the case of "die-back,"[1] when the nitrate will cause the tree

[1] We learn from Stockdale that this disease does not readily attack trees in a vigorous condition of health; and again, Hart tells us that the principal destruction to the trees and pods appears to occur on poorly cultivated or inferior soils.

to "flush," so to speak, like a tea-plant, and to thus successfully combat the disease even when hovering over its very branch-tips. The rapidity with which nitrate acts, and the strong stimulus it so promptly gives to the growth of the plants, adapts it for this purpose in a very special degree, and no other manure in common use is capable of being substituted for it.

There are no doubt hundreds of plantations of various descriptions in the Tropics where the crops are beginning to show a falling off year after year, even if only in a small degree. In most cases, and certainly so with cacao, in the West Indian Island of Trinidad, this state of affairs is undoubtedly due to the fact that one or other of the essential plant-foods is lacking *on the soil. Surely the planter or* farmer will come to the conclusion that it is worth while to gain at least some elementary knowledge of the necessary plant foods, and of the means whereby a deficiency of any or all of them can be supplied at a comparatively small expenditure of time and money, for which he will be more than repaid in the increased yield and value of his crops.

MANURING.

By Prof. Hendricksen, of Cuba.

Wright[1] says, "But few soils in the Tropics which have been under cacao cultivation for a few years are so rich as to be able to produce the best crops without artificial aid, and it is generally accepted that the supplying of plant-food is conducive to better and more rapid development of the plants, and in most cases is essential."

This is a fact well recognized by departments of agriculture and men in charge of botanic stations, but manuring is such a complicated problem that it is not well understood by all estate managers.

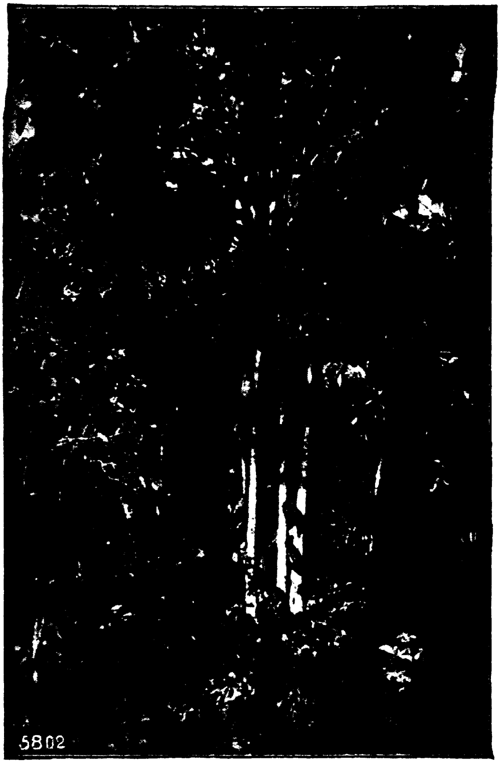
Tropical soils are, as a rule, fertile, but they are seldom as rich as popularly believed, and they are almost invariably exhausted sooner than soils in the North under similar treatment. Of course, soils in Europe are not abused to the same extent, and they are coming to realize in North America also that

[1] "Cacao, its Botany, Cultivation, Chemistry, and Diseases," by Herbert Wright.

even rich virgin land soon gives out under a system of soil robbery.

There are two problems confronting the planter, viz., how to maintain the fertility of new land, and how to build up old land. The first one is decidedly the easiest, but it is the one usually neglected, because nobody sees the necessity for doing anything before the crops send out a danger signal. When that stage is reached the problem is more serious, and it requires all the ingenuity of an estate manager to make up for lost time.

In speaking of maintaining the fertility we always mean the preservation of three or four elements, viz., nitrogen, potassium, phosphorus, and lime. Those are the elements needed in large quantities by cultivated plants, and they are all present in virgin soils suitable for cultivation. Some soils contain much and others but little of all or any one of those elements, but whatever the quantity, it is the duty of an estate manager to treat his plantation in such a way as to enable the crops to derive full benefit from it. The elements are more or less unavailable as plant-food because of the chemical combinations in which they are



CACAO SHADING COFFEE, GUADELOUPE.

present in the soil. The problem is to make them available for the crops without any unnecessary loss.

Nitrogen, which is the most expensive element, is contained in humus or organic matter in the soil. Such organic matter, like leaf-mould in forest land, usually undergoes decomposition, in which nitrogen is formed, and if such decomposition goes on too rapidly much of it is lost through evaporation in the form of ammonia, and through leaching of nitric acid and nitrate compositions. This takes place especially on land suddenly denuded of forest growth and exposed to sun and wind, and it should be prevented by planting some cover and catch crop as soon as possible.

Land denuded of vegetation loses not only nitrogen, but potassium, phosphorus, and lime as well. A certain amount of these elements in virgin soil are soluble in water and leach away. Most of them, however, are locked up in insoluble combinations, and become available as plant-food by the action of acids formed by decaying organic materials. Humus, therefore, is of direct as well as

CACAO TREE IN BEARING, TRINIDAD (B.W.I.).

indirect importance, and the man who manages to maintain the humus content in his soil has the problem more than half solved. A great many tropical soils contain fairly large amounts of potassium and phosphorus, and still the plants are starving because of the need of those elements. A soil may contain a hundred tons or more of potassium per acre, and yet an application of that element in the form of sulphate or muriate may cause a substantial increase in the crop. This may be explained by the fact that the potash combinations in the soil are not being dissolved fast enough. Therefore a soil may need an addition of soluble plant-food, even though a chemical analysis showed an abundance of insoluble present.

Lime is no less a plant-food than potassium and phosphorus, but it is usually present in sufficient quantity to do its share in nourishing the plant. It has another *rôle*, however, viz., that of neutralizing soil acids, and should be used for that purpose. A soil that is acid enough to colour litmus paper will be benefited by lime, because such acid condition is not favourable to bacterial growth in the soil, and

soil bacteria are of the greatest importance. It should be remembered, however, in applying lime, that an over-abundance of it will cause a too rapid decomposition of organic matter, and consequently loss of nitrogen. Therefore, no more should be applied than will neutralize the acids—say about a ton per acre on ordinary soil.

Cultivation and Fertilization.

In examining figures relating to the yield of cacao trees in the various islands, we find that the average yield in Trinidad[1] is under rather than over 1½ to 2 lb. per tree, whilst in Grenada it is as high as 2 to 3 lb. and over. In St. Lucia about 1 lb. per tree is obtained without much attention, and 2 to 3 lb. when the trees are cultivated and fertilized. In Cuba[2] the average is 4·9 lb. per tree, and in San Domingo[3] 3 to 5 lb. per tree. This discrepancy is not due to the more favourable climate in Cuba and San Domingo, nor to better care. On the contrary, the climate of

[1] *West Indian Bulletin*, vol. viii., No. 4.
[2] Cuba census of 1907.
[3] Unofficial.

the British Islands is more favourable, if anything; and although the planters there, until lately, have not paid much attention to cultivation and fertilization, the plantations are in most places better cared for than in Cuba and San Domingo. The reason undoubtedly is that, in the latter islands, cacao is not grown extensively enough to cause the planters to be obliged to use old worn-out land, while in the British Islands the estates are often located, not only on somewhat exhausted lands, but also in situations not naturally suitable for the cacao tree.

It has been the watchword for the last few years to increase the yield and raise the quality of all crops, and many of the ablest men in the various agricultural departments are now engaged in cacao investigations in the laboratory as well as in the field. Field experiments, especially manuring tests, have been conducted for a number of years, and while the results are not uniform, the general conclusion reached is that manuring is necessary in order to increase the yield.

Manurial experiments have been conducted for years in Dominica by Hon. Dr. Francis

Watts, formerly Superintendent of Agriculture for the Leeward Islands, and now Imperial Commissioner of Agriculture for the West Indies. Speaking of an experiment at Picard,[1] he says: "Each of the constituents of manure [phosphate, potash, and nitrogen (as ammonia)] has increased the number of pods in a marked degree, and this has been the case whether the constituents have been used singly or grouped in various ways."

An experiment conducted by Mr. Joseph Jones at the Botanical Station, Dominica, and reported on by Hon. Dr. Francis Watts, may be worth recording, as it was carried on for a number of years on five plots of $\frac{1}{4}$ acre each.

From this it will be seen that the soil was deficient in available plant-food, and that manuring was a paying investment, especially on plot No. 4, where the three plant-food elements—potash, phosphoric acid, and nitrogen—were used together. Plot No. 5 is a striking example of the influence of mulching, which is manifold. Mulch supplies plant-food, it improves the physical condition of the soil,

---

[1] *West Indian Bulletin*, vol. ix., No 2.

Plot No.	Manure per acre per year	Yield of Cured Cacao per Acre					Average for five years	Cost of manuring per acre		Value of increase per acre over unmanured plots at 6d. per lb. of cured cacao		Gain per acre by manuring	
		1902-03	1903-04	1904-05	1905-06	1906-07							
		lb.	lb.	lb.	lb.	lb.	lb.	s.	d.	s.	d.	s.	d.
1	No manure	1,138	822	1,009	1,122	1,095	1,037	...		...		...	
2	Basic slag, 400 lb.; sulphate of potash, 150 lb.... ...	1,540	1,170	1,179	1,105	1,285	1,256	45	3	109	6	64	3
3	Dried blood, 400 lb. ..	1,491	1,132	1,132	1,231	1,134	1,224	36	0	93	6	57	6
4	Basic slag, 400 lb.; sulphate of potash, 150 lb.; dried blood, 400 lb.	1,599	1,069	1,418	1,506	1,461	1,411	81	3	187	0	105	9
5	Mulched with grass and leaves	1,300	1,092	1,338	1,724	1,743	1,439	60	0	201	9	141	9

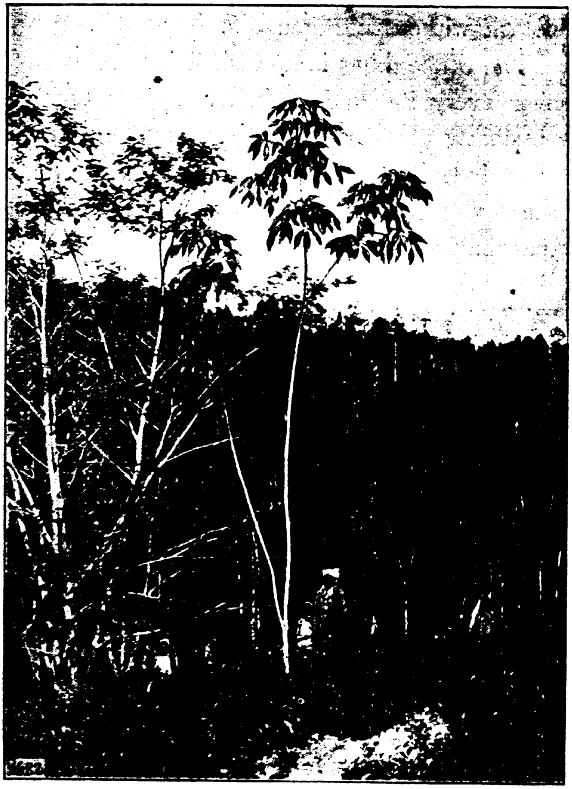
and converts the insoluble mineral plant-foods into forms in which they are available to the plants. It conserves the moisture, keeps down the weeds, and maintains conditions in the soil that are favourable to the growth of cultivated trees.

The difficulty with mulch, as with stable manure, is that it cannot be obtained in sufficient quantities in the West Indies, and counting the actual cost of mulch, when it has to be brought in from outside fields or woods, it is usually as high as commercial fertilizers. There is no question, however, that the use of mulch, together with commercial fertilizers, is one of the best means of increasing the yield of cacao.

Whether to use mulch or not will naturally depend on local conditions, and the kind of fertilizer to be used, as well as the amount that it will pay to apply, will also vary according to soil and climatic conditions. This is well illustrated by the results obtained in the various islands. For instance, Dr. Watts found in Dominica that an application of phosphate and potash did not pay without nitrogen, while Mr. Anstead found in Grenada that although

phosphate without nitrogen exerted no benefit, potash without nitrogen did.

The whole thing in a nutshell is that, whenever every intelligent planter awakes to the possibility of the benefit that may be gained from independent study and experimenting, the various agricultural questions will be more than half solved.



THREE YEARS OLD.

Strong application of Potash (15 per cent), weak application of Nitrogen (4·5 per cent.). Circumference of stem 1 inch from base: Beginning of 1905, 9 in.; June, 1906, 14 in.

THE MANURIAL REQUIREMENTS OF RUBBER TREES.

Up to the present time artificial manures have not been very largely used in the cultivation of rubber, but this practice is now coming more into favour. This is due to the results of many experiments, which have shown the following advantages :—

(1) A healthier and better growth of the trees, causing them to be available for tapping earlier, and to be more resistant to the attacks of diseases and blight.

(2) The trees grown on cultivated and manured land give a greater increase of growth each year, and this increases the amount of tapping that can be carried out.

(3) There is a quicker and more thorough renewal of bark, and as a result a larger yield of rubber per annum.

(4) An increased and more regular flow of latex.

(5) The growth and vitality of the root system is considerably developed. This result is of very great importance in the drier zones, as the deeper and more widely spread the root system is carried, the smaller the chance of the tree being effected by drought and the more unvarying the latex return during the drier seasons of the year.

For the above reasons the application of artificial manures to rubber trees in bearing is an economical and necessary concomitant of their successful and permanent cultivation. In most countries artificial manures are obtained at a comparatively small cost, so that the expense of using them is much more than counter-balanced by the good results previously mentioned on the growth and yield of trees.

In some countries rubber plantations are found on rich virgin soils, but nevertheless in many cases the application of artificial manures is found to have a very well-marked and valuable effect. In other parts rubber plantations are found on very poor soils, and in these cases there is no question at all as to the value of applying artificial manures. The same may be said of rubber growing among

THREE-YEAR-OLD RUBBER TREES.

Too strong an application of Nitrogen (6 per cent.), too weak an application of Potash (5 per cent.). Circumference of stem 1 in. from base: Beginning of 1905, 9½ in.; June, 1906, 13 in.

tea. Here the artificials have a double effect, for whilst improving the growth and yield of the rubber they also improve the quality and increase the yield of the tea; on lands where tea is growing a larger application of manures can be given than on land only carrying rubber trees, as the ground is more thickly covered with plant life.

The question that now comes to the front is, What manures should be applied? Here I would again state that the three plant-foods most often required on account of their being deficient in the soil are nitrogen, phosphates, and potash, and all planters of rubber should make it a rule to include these three plant constituents in the manure to be applied, and also to give them in the proper proportions as required by the plants.

I will take a short course over the three plant-foods, and commence with the one that requires the most care. The application of too much nitrogen tends to make the plants produce very quick growth, and this causes the trees to become very weak and tender, and very liable to be broken down by the wind, as the accompanying photographs show.

FIVE-YEAR-OLD RUBBER TREES.

Strong application of Potash (15 per cent.), weak application of Nitrogen (4·5 per cent.). Circumference of stem 1 in. from base: Beginning of 1905, 18 in.; June, 1906, 24 in.

The illustrations on pp. 128 and 131 show the effect of an experiment on the manuring of rubber trees in Ceylon, which was carried out by Mr. R. M. Eckert, Vincit, Ruanwella. That on p. 128 shows the effect of a rational manuring which consisted of—

	Potash.	Phosphoric Acid.	Nitrogen.
20 per cent. Castor Cake, 10 ,, Rape Cake	—	—	1·8
10 ,, Crushed Fish	—	0·4	0·6
10 ,, Bloodmeal	—	0·1	1·3
20 ,, Bonemeal	—	4·0	0·8
30 ,, Muriate of Potash ...	15	—	—
100 per cent. contains	15	4·5	4·5

This gives a well-balanced manure, and the photograph shows the state of the trees in 1905, when they were found in a very healthy condition. When notice is taken of the photograph on p. 131 quite a different aspect is seen: this tree, which is in the foreground, has been manured by a mixture containing—

	Potash.	Phosphoric Acid.	Nitrogen.
25 per cent. Castor Cake, 15 ,, Rape Cake	—	—	2·4
20 ,, Crushed Fish	—	0·8	1·2
10 ,, Bloodmeal	—	0·1	0·3
20 ,, Bonemeal	—	4·0	0·8
10 ,, Muriate of Potash ...	5	—	—
100 per cent. contains	5	4·9	5·7

This mixture contains a higher percentage of nitrogen and a lower percentage of potash,

FOUR-YEAR-OLD RUBBER TREES.

Too strong an application of Nitrogen (6 per cent.), too weak an application of Potash (5 per cent.). Circumference of stem 1 in. from base: Beginning of 1905, 9½ in.; June, 1906, 13 in.

with the result that the tree is seen in a very weak-wooded condition, the stem being bent right over owing to the growth of a heavy top with too much leaf growth. But the result of this experiment was further demonstrated in 1906, when the characteristics shown were as in the photographs on p. 133 and 135.

The trees illustrated on p. 133 are manured with the same mixture as those shown on p. 128, containing a large percentage of potash and a small percentage of nitrogen, and the trees are all in a good healthy condition, whilst the illustration on p. 135 shows that the application of manure containing too large a percentage of nitrogen and too small a percentage of potash has resulted in the tree, owing to the tenderness of the wood, being broken down by the wind and thus destroyed. This affords a good illustration of the effect of too high a proportion of nitrogen, but, at the same time, nitrogen cannot be left out of a manurial mixture, as the potash, phosphoric acid and lime, without nitrogen, do not appear to have their full effect, owing to the deficient leaf growth of the tree, and this means a deficiency in the yield of latex, as it is now

generally recognized that the leaf area governs the latex supply.

Phosphoric acid is also essential in a manurial mixture as it is found to be beneficial in not allowing an excess of leaf growth, but potash appears to hold the most important relation to the rate of growth of the trunk and branches, provided it is accompanied with sufficient supplies of phosphoric acid and lime, and a reasonable quantity of nitrogen to induce free growth and the absorption of the three inorganic ingredients above mentioned.

Now comes the question of the form in which the manures should be employed. Nitrogen can be employed in the organic form as fish guano, bloodmeal or oil cake, or inorganic as nitrate of soda[1] or sulphate of ammonia.

Phosphoric acid can be employed in various forms, such as superphosphate or basic slag, but on soils that are deficient in organic matter bones are useful.

Potash may be employed in the form of muriate or sulphate, and in many cases in dry climates muriate seems to have the best

[1] See p. 36, on its immediate effect on rubber yields.

results, and should therefore appeal to Ceará planters.

The following mixture is suitable on land rich in nitrogen and where there is a good leaf growth :—

			Potash.	Phosphoric Acid.	Nitrogen.
28	per cent.	Muriate of Potash (50)	14	—	—
25	,,	Superphosphate (18) ...	—	4·50	-
20	,,	Bonemeal (28/1) ...	—	5·60	0·2
17	,,	Oil Cake	—	—	1·3
10	,,	Sulphate Ammonia ...	—	—	1·6
——	,,		——	——	——
100	per cent.	contains	14	10·1	3·1

400 to 800 lb. per acre to be applied.

On land which is very poor the following mixture is to be recommended :—

			Potash.	Phosphoric Acid.	Nitrogen.
20	per cent.	Muriate of Potash (50)	10	—	—
30	,,	Superphosphate (18) ...	—	5·4	—
10	,,	Bonemeal (28/1) ...	—	2·8	0·1
24	,,	Sulphate of Ammonia (20/5)	—	—	4·9
16	,,	Oil Cake (6)	—	—	0·1
——			——	——	——
100	per cent.	contains	10	8·2	6·0

400 to 700 lb. per acre to be applied.

The next question which comes to the fore is, When is the best time to apply these manures, and the method of applying them? Artificial manures should not be applied during heavy rains or just previous to the rainy season, as if then applied there is considerable loss due to drainage.

The manures can be sprinkled round the

tree at a distance of from 1 to 1½ ft. from the stem for each year of the plant's growth, and then thoroughly forked into the soil, or, in order to ensure that the manure is not washed away, a shallow trench may be cut round the tree, and the manure forked therein and the surface soil then replaced.

Another point which should not be forgotten with regard to the manuring of rubber is that there is a very large advantage to be obtained by green manuring, whilst the use of litter and cattle manure is also of the greatest advantage.

Cattle manure has a twofold effect, viz., besides acting as a direct manure it is also of very great influence in ameliorating the soil, whilst the acids formed are of great benefit in making the insoluble salts in the soil become soluble and thus capable of being more readily taken up by the plants.

The chief thing to take into consideration about farmyard manure is that in tropical countries it is very scarce, and with the supply available it is best applied to crops other than rubber, and for this crop only to apply artificials, with frequent green manuring.

As has been previously stated, the value of green manuring is very large, but it is necessary to notice that the fullest advantage is only obtained when it is supplemented, at the time of burying, by an application of potash and phosphoric acid. For this purpose the potash is best applied in the form of muriate, and the phosphoric acid either as superphosphate or basic slag.

The following mixture should be employed at the time of green manuring:—

		Potash.	Phosphoric Acid.	Nitrogen.
34 per cent.	Muriate of Potash ...	17	—	—
44 ,,	Superphosphate ...	—	7·9	—
22 ,,	Bonemeal	—	6·2	0·2
100 per cent.	contains	17	14·1	0·2

Of the above mixture 600 to 900 lbs. per acre can be applied.

If the above points are attended to and a liberal supply of potash, phosphoric acid and nitrogen given, with periodical applications of green manuring, very successful results and profitable returns can be obtained in the cultivation of rubber.

GREEN MANURING.

RUDOLPH ANSTEAD shows that green manuring, even of a poor character, increases the yield of rubber, as it keeps the soil moister. On examination it was found that although the green manure was dead, the soil on which it had been planted was moister than that which had been clean weeded, as the dead remains of the green crops absorb and retain moisture more firmly than the ordinary soil, and so pass it on to the rubber-tree roots. Stockdale reports that: "In the Botanic Gardens, British Guiana, the growth of hevea plants has been greatly improved by the use of green cover crops. The soil is not suitable for hevea, but plants after a green cover crop was planted have grown much more rapidly than previously. This method will be tried experimentally during the next year." This increased moisture supply at the roots of the rubber trees

[1] *Planters' Chronicle*, of Bangalore, S. India.

tends to increase the flow of latex, as in the early morning and evening, if there is any moisture, and no rubber estate can be entirely devoid of water, the roots take it up quicker than the leaves evaporate it. This causes a great pressure in the bark cells, which should account for a larger flow of latex in the morning and evening. Planters of Ceará (*M. Glaziovii*), even in very dry and exposed places, might thus be able to bring some help to the trees by green mulching, for even if this dies it seems probable that the soil would still contain 10 per cent. or more of moisture, on account of the dead vegetation. In any case the matter is worth noting and experimenting with.

Ceylon is of course the pioneer with regard to green manuring. The Botanic Gardens, and more especially Mr. Kelway Bamber, have been advocating and experimenting with green manures for the last ten years, and Dadaps and Crotalaria are now being widely adopted.

Mr. F. Zernichow[1] recommends *Tephrosia purpurea*[2] for green manuring, as being able to

[1] *Tropical Agriculturist*, April, 1910, p. 297.

[2] For figures showing profit and loss account when using *Tephrosia purpurea*, see *Planters' Chronicle*, Bangalore, vol. v., No. 22.

keep down weeds, and perhaps to benefit the trees, whilst at the same time it should help to keep the soil moister.

I think that it was my Belgian contemporary, *L'Agronomie tropicale*, that also called attention to this leguminous plant (*Tephrosia purpurea*) as being suitable for clearing the land of troublesome or dangerous weeds on rubber, coffee and other estates. The *Tephrosia*, we are told, grows slowly at first, but towards the end of four months it attains the dimensions of a small bush, and it is then that it commences to show its superiority over other plants as a weed extinguisher. In British Guiana, Stockdale says that this plant does not grow to more than 2 ft. 6 in., and its dwarf habit recommends it. A cover crop that runs up to 9 ft., which some maintain *Tephrosia* will do, probably could not be topped cheaply enough to make it advantageous. What is needed are very dwarf, close-growing plants. *Tephrosia* is largely used in Java, and latterly in the Federated Malay States. In plantations, it forms hedges across which no other plant can pass, and these hedges are sufficiently distant to allow the air to circulate

between the trees, and yet the shrubs keep the soil well shaded and in good physical condition.

Commenting on this article, the *Agricultural News* points out that by utilizing the *Tephrosia* a great saving in labour bills is effected. Although I do not know the plant, I understand that several species are common in the West Indies, where they are known under various local names, as "goat rue" (*T. cinerea*), "Surinam poison" (*T. toxicaria*), &c., but whether all these are as useful or efficacious as weed-preventers as the *T. purpurea* remains to be seen. The *Agricultural News* describes the *T. cinerea* as a loosely spreading under-shrub which tends to run along the ground with a stem 1 ft. to 1½ ft. long. The *T. toxicaria* is an upright larger plant with an erect stem about 4 ft. to 5 ft. high. Here, however, supposing such shrubs could be planted out in Malaya on the rubber estates to keep down weeds, it would seem as if we might have too much woody matter liable to be attacked by *Fomes*, since that pest has already shown an inclination to attack *Crotalaria* to such a degree that there is some doubt whether, of the two evils, lalang lands, which

seem so far to have been immune from the fungus disease, are not better than lands planted up with *Crotalaria*. According to Mr. Petch, the statement that *Fomes* attacks *Crotalaria* is quite wrong. In centres, however, where the fungus has not made its appearance it should be worth while to give *Tephrosia* a trial so as to keep down weeds, to shade the ground, and to prevent erosion after heavy rains.

In my "Future of Cacao Planting," I urged mulching cacao and green manuring lands to increase their fertility. Last year Mr. Rudolph Anstead, writing on mulching and soil inoculation in connection with experiments conducted with cacao in Grenada, reported that:—

"The remarkably good results obtained by mulching cacao at the Dominica Botanic Station during the past two years have created a great interest in this subject in Grenada. The difficulty is to obtain material with which to mulch large areas. It is a comparatively easy matter for small proprietors to obtain mulching material from the waste lands, and many of them have taken full advantage of

this; but on many of the large estates this is not the case, there being little waste land except that in the mountains, which is difficult of access, or very poor lands which grow practically nothing at all.

"The problem would be solved if some green crop could be grown under the cacao, and from time to time attempts have been made to grow a leguminous crop, such as woolly pyrol, but all attempts have failed, and nothing has been discovered which will grow in the heavy shade under cacao.

"Mr. O. W. Barrett, addressing the Trinidad Agricultural Society, advocated the use of the cowpea, which, he asserted, would grow under heavy shade, and he attributed failures with this crop to the possible lack of the necessary bacteria in the soil. The lack of light must, however, have caused the failure, and it is generally agreed that to grow cowpeas under cacao is impossible. The following, however, is worth noting:—

"In view of this, some further experiments were undertaken, during the year under review, with cowpeas obtained from Barbados. These were inoculated before being sown with a

culture grown at the Botanic Station from inoculating material specially prepared for cowpeas obtained from the U.S. Department of Agriculture. The expenses incurred were met by a special vote granted by the local Government.

"The following scheme of experiments was carried out in connection with the experiment stations on six estates, viz.: Mount Horne, Dunfermline, Tuileries, l'Esterre, Diamond, and Dougaldston, as well as at the Botanic Station.

"(*a*) A plot of ½ acre on ordinary soil in the open was sown with uninoculated cowpeas.

"(*b*) A similar plot of ½ acre side by side with the last was sown with inoculated cowpeas.

"(*c*) A plot of 1 acre under full-grown cacao, giving an average amount of shade, was sown with inoculated cowpeas.

This scheme was devised to answer two questions: (1) whether any benefit is to be obtained from inoculation, in Grenada soils, of leguminous crops like cowpeas; and (2) whether by inoculation leguminous green dressings, such as cowpeas, can be grown under the shade produced by full-grown cacao

"The experiments were commenced at the end of May, the necessary seed being distributed from the Botanic Station, when all the land was ready for planting.

"The results obtained have unanimously given a negative answer to the last question. The shade experimented with varied from fairly light to very dense, and in no case, in spite of inoculation, did the peas do more than produce one or two leaves, and they soon died, showing all the symptoms of lack of sufficient light. This result confirms experiments made in Grenada on somewhat similar lines, but without inoculation, some years ago, and it may be therefore considered as settled definitely that under the dense shade produced in Grenada, by 'covered-in' cacao, where weeds will not grow, no green dressing at present known can be made to grow.

"With regard to the first question, the benefit of inoculation in the open, the results obtained were valuable. At the Botanic Station, Dunfermline and Mount Horne, no advantage was gained at all from inoculation; both plots, (*a*) and (*b*), gave precisely the same results and yield. This may possibly have

been due to the fact that the soil experimented upon was already rich in organic matter.

"At l'Esterre and Tuileries there was a slight difference in favour of the inoculated plot, in yield, general health and growth, but it did not amount to anything very great. The experiments are being repeated on these estates, the peas being resown on the same plots. The next results should prove of interest.

"The chief interest centred in the results obtained at Diamond and Dougaldston estates. At Diamond, Mr. W. Malins Smith reported that the soil experimented upon was moderately good soil which has never been manured, but was in good tilth. Here the advantage of inoculation was very noticeable, for Mr. Malins Smith further reports that the inoculated plants were about one-quarter as big again as the uninoculated ones, and that the yield of green dressing was large in proportion.

"At Dougaldston the inoculated plot gave a much greater yield than the uninoculated one.

"Wherever cacao is not entirely 'covered in,' and there are open spaces among the trees, leguminous plants can, and should, be grown instead of weeds.

Rubber in Bolivia.

"In view of the importance of green dressings, especially of leguminous crops, to cacao planters, these inoculation experiments should be continued on a larger scale, and with a large variety of leguminous plants, and they should be conducted upon the poorest possible soils, as these always respond better to inoculation than soils well supplied with nitrogenous plant foods. If the poor, waste lands can, by inoculation, be made to yield good crops of some leguminous plant, the problem of finding sufficient mulching material would be solved to a great extent, and poor lands improved.

Plots of various kinds of likely plants such as *Crotalaria*, *Canavalia* and different varieties of peas, &c., have been established at the Botanic Station to gain an idea of their suitability, and to obtain seed for distribution during the coming year."

For green dressings or manuring generally, I would call attention to the annual report of the Curator—Mr. T. B. Jackson—of the Botanic Station, Antigua (W.I.), published by the Imperial Department of Agriculture for the West Indies, as being worthy of attention :—

"Several crops were grown at the Aguanti

Experiment Station with a view of testing their merits as green dressings. In Antigua the value of green dressing crops is becoming more appreciated year by year. The figures on the next page, which give the results obtained from a number of plants grown for this purpose, will be interesting.

"COWPEAS.

"The growing of cowpeas for green dressings has somewhat decreased in Antigua on account of their susceptibility to attacks by caterpillars, Barbuda beans having to some extent taken their place. The varieties under trial on this occasion were free from any insect attacks.

"Four varieties of cowpeas were grown at the experiment plots during the year under review. Of these the variety "Iron" gave 17,570 lb. of green bush per acre, or 1,290 lb. more than the Barbuda bean.

"BARBUDA BEAN.

"This bean has long been grown in Barbuda, its chief features being its immunity to insect attacks and the heavy cover of green growth given by it.

RESULTS OF GREEN DRESSING EXPERIMENTS.

Local Name	Botanical Name	Area of Plot	Time of Planting	Time when Reaped	Weight of green bush in pounds	Weight of green bush per acre in pounds
Cowpea, Iron	*Vigna unguiculata*	$\frac{1}{10}$ acre	Jan. 8 ...	April 8 ...	1,757	17,570
,, Clay	,, ,, ...	,, ,,	,, ,, ...	,, ,, ...	1,484	14,840
,, Black Eye ...	,, ,, ...	,, ,,	,, ,, ...	,, ,, ...	1,200	12,000
,, Speckled ...	,, ,, ...	,, ,,	,, ,, ...	,, ,, ...	1,199	11,990
Barbuda Bean	*Phaseolus lunatis*	$\frac{1}{40}$,,	Nov. 4 ...	March 20 ...	407	16,280
Chicory	*Cichorium Intybus*	$\frac{1}{80}$,,	Oct. 30 ...	April 23 ...	60 lbs. green bush, 105 lbs. roots	13,200
Sword Bean or Overlooker	*Canavalia gladiata*	$\frac{1}{40}$,,	Nov. 4 ...	June 17 ...	330	13,200
Babricou Bean	*Canavalia* sp. ...	,, ,,	,, ,, ...	,, ,, ...	294	11,760
Woolly Pyrol	*Phaseolus Mungo*	$\frac{1}{10}$,,	Jan 19 ...	April 21 ...	1,023	10,230
Java Crotalaria	*Crotalaria* sp. ...	$\frac{1}{40}$,,	Nov. 5 ...	June 18 ...	240	9,600
Dwarf Essex Rape ...	*Brassica Napus* ..	$\frac{1}{20}$,,	Oct. 30 ...	Dec. 20 ...	443	8,860
Bokhara Clover	*Melilotus* sp. ...	,, ,,	,, 31 ...	April 23 ...	244	4,880
Thousand-headed Kale ...	*Brassica oleracea fimbriata*	$\frac{1}{60}$,,	June 13 ...	Sept. 31 ...	73	4,380
Pigeon Pea	*Cajanus indicus* ...	$\frac{1}{10}$,,	,, 15 ('08)	June 18 ('09)	400	4,000
Mustard	*Brassica nigra* ...	Planted June 13. Growth vigorous. Attacked by caterpillars and did not recover.				
Vetch	*Vicia sativa* ...	Planted June 13. Very poor; was not weighed out.				
	Lathyrus latifolus	Planted June 13. Very poor; grew to height of 4 in. and died.				

"Inquiry has shown it to be identical with the well-known *Phaseolus lunatus*, or Lima bean, of the East, and it is thought its immunity to insect attack may be due to the development of hydrocyanic acid in the leaves. It appears that it was originally imported into Barbuda as a provision crop for feeding slaves.

"The Barbuda bean is, perhaps, at present the most popular plant for green dressing purposes in Antigua. As will be seen in another part of this report, 270 lb. of it were sent out from the Botanic Station for planting purposes during the year. In addition, many estates bought supplies direct from Barbuda, and others established their own nursery plots. At the Experiment Station the seeds are planted from 1 ft. to 18 in. apart, on each side of the banks, and as they germinate very readily one only is planted in each hole. If the weather is at all favourable, a good stand can be depended on from the first planting.

"The crop remained free from insect attack, and no report of its being attacked on any estate has been received. It may be well to mention that this bean is also most popular in Antigua for culinary purposes.

"CHICORY.

"Chicory is a composite plant, the leaves of which are sometimes used as a salad, and the roots for adulterating coffee. It possesses long tap roots, the length of some growing at the Experiment Station being from 18 in. to 2 ft. These would perhaps do useful work on the heavier lands by aerating the soil, but the plants might prove a troublesome weed if introduced, for after ploughing or forking small pieces of the root grow readily.

"The seed of this plant was sown broadcast on the flat; it germinated readily, and a good stand was obtained. The weight of roots and green bush was good, but it will be observed that the weight of the former was nearly twice as great as that of the latter.

"SWORD BEAN, OR OVERLOOKER BEAN.[1]

"From these limited experiments it would seem that plants such as the horse-bean (*Canavalia gladiata*), which are natives of Antigua, are more suited for local purposes than the imported cowpeas, &c. The draw-

[1] This has proved a great success in Jamaica, I am told.

back to canavalias as green dressings is their somewhat slow growth; for instance, the bean under consideration was in the ground for seven months, and would have improved if it had been left to grow, whereas a crop of cowpeas will be at its best eighty or ninety days after sowing. The seeds on this plot were planted 2 ft. apart; the writer is of opinion, however, that closer planting would give better results.

"It is a hardy, trailing plant, possessing a curved or sword-shaped pod, in which there are large, reddish seeds. It remained perfectly free from any insect attack, and would form a useful addition to the plants suitable for green dressing purposes in Antigua.

"BABRICOU BEAN.

"This is a plant similar to the sword bean, and to which the same remarks apply.

"The seed of this was received from Dominica about two and a half years ago. It is stated that slaves were fed with it; at the present time, however, it is not used for culinary purposes. The pod is much smaller than that of the horse-bean, and almost semi-

circular in shape. The seeds are of a dirty, brownish-yellow colour. It is probably *Canavalia obtusifolia.*

"WOOLLY PYROL.

"The growing of woolly pyrol as a cover crop is slightly on the increase in Antigua, especially in the southern part of the island, where successful crops have been grown. During dry weather it is susceptible to attacks of red spider, which during the year did more damage than caterpillars.

"CROTALARIA SP.

"The seed of this plant was received from Java some twelve months ago. It is a hardy, upright, somewhat woody plant, growing to the height of about 2 ft. Its foliage is immune from insect attack, but it has been noticed recently that the pods are attacked by a caterpillar. In spite of this, numerous seeds are set, so that it should not be prohibited from being tried on estates as a green dressing. It will be seen that it gave more than twice as much green bush per acre as the pigeon pea. It could be used for land that is

to remain in green dressing for some time, say, twelve months, and it would form a good substitute for pigeon peas.

"This plant is probably *Crotalaria striata*.

"Rape.

"This plant belongs to the cabbage family, and is grown in temperate climates for feeding stock. It grew vigorously, but was attacked by caterpillars; these were controlled by applying Paris green and lime in the proportion of 1 to 6.

"Bokhara Clover.

"Bokhara clover is also grown in temperate climates as a stock food. The seed of this should only be sown on thoroughly clean land, as the growth at first is slow. The weight of green bush (244 lb. from $\frac{1}{5}$-acre plot) is not great, but the figures given only represent one cutting. At the time of writing the plants are making a fair second growth. The crop might be tried on a small scale on estates for cattle food.

"Thousand-headed Kale.

"This grew steadily, but was attacked by caterpillars, and was reaped before it reached maturity.

"PIGEON PEA.

"This is grown to some extent in Antigua as a green dressing, but it should be noticed that the yield of green bush per acre from it is less than that from other plants grown as cover crops.

"It might be well to state here that it is the practice at the Experiment Station never to turn in a dressing crop in a green state; it is allowed to lie on the ground twenty-four to forty-eight hours before it is turned in. This is done to prevent any possible souring of the ground, which sometimes ensues after turning in green manure in a fresh state."

Stockdale warns us to use it with caution. Cover crops are, among other benefits, planted to keep the ground moist, but Mr. Stockdale points out that pigeon peas dry up the land to a considerable extent, and, therefore, should not be used in any dry district except as a rotation crop at the proper season of the year.

GREEN MANURING AND THE USE OF COVER CROPS.

When considering the all-important subject of soil management there is one point to which

planters often do not give sufficient weight, and that is the damage and monetary loss caused by wash.

The top few inches of the soil are over and over again the most important of all to the crop. Endless time and money is spent in getting a good tilth and making the surface soil of such a mechanical condition that it will readily absorb moisture on the one hand and retain it on the other. This top soil, when in good condition, is the home of myriads of bacteria which render the fertilizing constituents available to the plant, and to it is added manures. Consequently every effort should be made to retain every particle of it if possible.

A large number of crops are more or less surface-feeders, and if they are permanent, like coffee, tea, rubber, cacao, &c., it is especially important that the surface soil should not be removed. The heavy rains experienced in the Tropics, often as much as 40 in. in a single month, if they fall on bare land carry away enormous quantities of top soil into the drains and rivers, and the rich alluvial plains of countries like India have been formed by years

of wash from the hills above them. Where estates are kept clean weeded and the soil left bare and exposed, the rivers and streams in wet weather are choked with fine silt being carried away, silt which represents the tilth so carefully obtained during the year, and it is no uncommon sight on such estates to see the roots of the tea or rubber, as the case may be, sticking up several inches above the level of the ground, showing where the old surface used to be and the loss which has been sustained. On all sides it is agreed that this is wrong estate practice, and all kinds of devices, such as trenches and pits to catch the soil, are resorted to in order to prevent the wash.

The simplest method of preventing surface wash is to grow a cover crop to break the force of the tropical rain and hold the soil together with their roots. The beneficial effects of such cover crops in controlling the loss of surface soil by wash are admirably shown by the following series of experiments conducted in Ceylon at the Peradeniya Experiment Station :—

Plot treatment	Wash in tons of soil from April, 1909, to March, 1910, per acre
Bare weeded ...	115
Dadap (Erythrina) ...	106
Deep forked ...	79
Albizzia ...	67
Crotalaria incana across slope ...	43½
Ipomœa ...	45
Mixed Crotalaria and Indigofera, 1 ft. apart up slope ...	26¾
Crotalaria across slope, 1 ft. apart in the rows ...	26½
Desmodium ...	12½

In addition to preventing wash and the loss of valuable soil, cover crops, if they consist of leguminous plants, have another beneficial effect. They add nitrogen to the soil year by year, the most expensive of all plant foods to buy. This they abstract from the air through the medium of bacteria in the nodules on their roots, a phenomenon too well known nowadays to need any description. Soils which have been under natural vegetation for many years are always found to be rich in nitrogen, and this nitrogen has been taken from the air and accumulated in the soil largely by the action of the leguminous plants in the flora. (Vide *Agricultural News*, viii., 199.)

It is sometimes objected that cover crops rob the primary crop of plant-food, but this

removal of food is *only temporary, as the* cover crops are never removed from the soil, but are from time to time cut down and dug in or allowed to rot on the surface, so that their constituents are restored to the soil, and in such a condition they become rapidly available to plants. The best plan is to apply dressings of potash and phosphates to the soil, and then grow a leguminous cover crop on it to supply the nitrogen.

The most suitable plant to grow depends upon local conditions; the flora of any estate, if carefully examined, will be found to contain many leguminous weeds, and it is both cheaper and easier to establish one of these than a plant introduced from another country or district which is very likely unsuited to the local conditions, or may be attacked by a local pest.

The ideal cover plant is a non-climber, which makes a thick cover and does not grow to a height of more than about 2 ft.; a rapid grower, persisting in the dry weather; not attacked by diseases to which the permanent crop may be susceptible, or by diseases of its own. Many plants can be found which comply with these demands fairly well, and such should be used.

The starting-point is a clean-weeded estate. There can be no half-way house between cover crops and clean weeding. The weeds should be removed and destroyed as soon as possible after the clearing is made, and it is essential that certain plants which are known to be harmful should be eliminated, and then the cover crop should be established and cultivated. It is no longer a "weed," but a desirable plant grown for a specific purpose.

Cover crops thus established aid the conservation of the soil, add nitrogen and humus to it, and at the same time reduce the weeding bill to a minimum—an item of estate expenses which is usually a very heavy one in the Tropics.

PREPARATION OF PLANT-FOODS FROM WASTE PRODUCTS.

In tropical countries there are many materials which yield oil on expression, leaving behind an albuminous substance which, in positions favourably located as regards transport, sometimes find a market as a food cake where it is suitable for feeding purposes, but which, in many cases, becomes a material which it is necessary to dispose of in the cheapest possible manner, on account of its unsuitability for animal food or for manurial purposes, owing to the residual oils which it is impossible to press out.

Such material, however, is a valuable manure, provided the oil can be removed entirely. Not only that, but it finds its most useful outlet in the district where it has been produced. An easy way to remove the oil is by extraction with liquid solvent. This is a cheap process, and, in addition, it is a very complete one, inasmuch as all the oil is removed.

In any case, by doing so, you rid yourself of a nuisance, but, as the result of doing so leaves behind a first-class plant food with a high nitrogen value in a dry form, and ready for immediate application to the soil, the process yields a double benefit to the planter.

In the more thickly populated districts, or outlying haciendas, estates, &c., where the cost of transport to any town or port is prohibitive, there are natural products which should receive more attention than they do. These are the animal residues in the way of bones, meat, skin trimmings, and so forth. All these materials, when the grease has been removed from them, are valuable food products high in phosphate and nitrogen value.

The same type of machinery can be used as in the case of seeds. The plant consists of one or more extractors, of a design in which the material to be degreased is let in at the top, and is there treated with benzine or similar solvent either in the liquid or the vapour form.

Whenever it is shown that the benzine is taking up no further oil or grease, the degreasing work is arrested, and the benzine is distilled from the oil, which takes place in a

special form of still. Meanwhile the benzine which remains in the material is driven off by steam heat, condensed in special tubular condensers, cooled and collected in a store tank, passing first through an automatic water separator.

It is then ready for re-use, and the loss is practically "*nil.*"

The finished material is raked out of the bottom doors of the extractors, which are then ready for a fresh charge. The material, when finished, is quite dry and ready to be bagged, or removed for use, except, in the case of bones, of course, which have to be ground, but they come away in a very brittle condition, and the grinding is accomplished without a great deal of power.

The question of the utilization of such waste products demands more attention than it has hitherto received. In the hope, therefore, to help in that direction, I have included the above remarks, and shall be pleased to go further into the matter with anyone, agreeing with my views, who wishes to obtain further particulars.

RUBBER IN BOLIVIA.
Receiving and Weighing a Weekly Delivery of Rubber at Chiniri Rubber Post, Bolivia.

INOCULATION AS A CURE FOR PESTS AND DISEASE.

Mr. W. Fox, Superintendent of Forests and Gardens, Penang, sent in the following notes on the "Angsana Tree Disease in Penang," and they were published in the *Straits Bulletin* of April, 1910:—

"Between thirty and forty years ago there grew along the sea-front in Malacca a magnificent avenue of Angsana trees (*Pterocarpus indicus*), and it appears that about that time they were attacked by some disease which killed practically the whole of them. Since that date up to within about four years ago, the Angsana tree, which is largely planted in the Straits, and especially so in Penang, seems to have been free from any attack; about the last-mentioned date, however, I noticed in Macalister Road, Penang, three medium-sized trees showing signs of disease. Examination showed no palpable cause, except an exudation of kino. The trees died in less than three months from the first sign of

attack, and were cut down and burned. A few months later, trees for the most part of the largest size, here and there along the road-sides, began to exhibit the same symptoms and eventually died, the greatest number dying during the year 1898-99. In all, close on a hundred trees have been killed by this disease, a calamity of no small magnitude, since I have said they were mostly magnificent trees, averaging a diameter at three feet from the ground of about five feet. As they form the principal shade-tree planted along our road-sides, it can be imagined how serious is the loss occasioned by the destruction of such noble trees, to say nothing of the labour involved in cutting them down. As regards the preventive measures adopted for arresting the spread of the disease, the usual one of isolation was tried, by digging a trench round the tree, throwing the infected soil inwards toward the stem, and liberally dusting the bottom and sides of the trench with lime and sulphate of copper, powdered fine. Unfortunately, from the situation of the trees along the public roads, with a metalled road on the one side and a ditch on the other, it was im-

possible to completely encircle the tree, consequently two trenches were cut, one on either side of the tree, from the road to the ditch. From such partial protection it was impossible to prevent the mycelium travelling under ground from tree to tree. The ultimate plan of cutting out every tree that was affected was adopted, and I am glad to say that although the disease is not perhaps quite stamped out, it is under control. During the worst of the epidemic I got permission of the Municipal Commissioners to invite Mr. Gallagher, the then F.M.S. Government Mycologist, to visit Penang and examine the affected trees. Together we examined a large number of trees and took specimens of the roots, bark, and wood; Mr. Gallagher succeeded in finding numerous hyphæ of an unknown fungus in the cell tissue, but was unable to determine the species in the absence of the carposphores or spore-bearing portion of the fungus. Subsequently I collected a number of these carposphores and sent them to Kew, where they were examined by Mr. Massee, the mycologist there. They proved to be of three species, two non-parasitic, and one, by far the commonest,

parasitic and presumably the one causing the mischief. It is named *Polystictus occidentalis.* I attach a copy of Mr. Massee's Memorandum on the material sent.[1]

I also received a sympathetic letter from the Director of Kew, Lieut.-Col. Prain, who mentioned that the Angsana was one of his favourite trees when in India; he told me what I was not aware of before, that the tree is not a native of India, as its name would suggest, but that it was introduced from the Moluccas, where it is really wild. It will be seen from Mr. Massee's notes that he thinks there is no known cure; the remedial measures he suggests can only be regarded as slightly prolonging the life of the tree.

"INOCULATION OR INJECTION SUGGESTED.

"Since the receipt of this communication I have read some extremely interesting work done by Mr. G. F. Scott-Elliot in the curing of plant diseases. The method adopted is by the injection of antitoxin as is done in medical practice. He also mentions an experiment made by Mohrzecki, where an apple tree suf-

[1] Not included.—H. H.S.

fering from chlorosis or the yellows, which presented a sickly and languishing appearance due to the chlorophyll (green colouring matter of plants) having developed imperfectly. An injection was made into the trunk of an apple tree (9 in. in diameter) of a solution containing 12 grm. of iron sulphate. In ten days there was no trace of chlorosis, and after three weeks the leaves were dark green, and to all appearances perfectly sound and healthy. Mr. Elliot describes the method as exceedingly simple, using plasticine or putty, in the case of small trees, to make a circular basin round the stem, which is filled with water containing the solution of the fungicide. In the case of large trees like our Angsana it would probably not be necessary to make a basin all round the tree, but probably a series of cups at short intervals round the base of the tree would suffice. The stem is then pierced with a sharp knife, when the fungicide would pass into the sieve tubes and so be taken up by the sap, and come in contact with the disease. Injection does not seem to be so successful with resinous and possibly also latex-bearing trees. The method, however, which is only outlined here,

seems to afford a very promising field for experiments."

A firm trading as Phytobie recommends the use of funnels driven into the side of a tree, into which liquid can be poured, and left to be absorbed by the tree.

Mr. Rudolph Anstead does not agree with my idea of inoculating plants against disease. At present it is a dream, come what may later on. Anything introduced into the internal system of the plant strong enough to kill a fungus will, he claims, be able to kill the plant. Nothing like an antitoxin has as yet been discovered.

Regarding the inoculation of the trees for black blight in Grenada, Mr. Malins Smith reports :—

(1) Experiments are being made now to determine whether the scale insects which cause the black blight could be destroyed by inoculating the trees with a fungus which preys on the insects.

(2) Some time ago the staff of our Agricultural Department discovered such a fungus on the mango scale "lecanium."

(3) Since then mango leaves containing

Sir J. D. Rees, K.C.I.E., &c.,
Chairman of the British Central Africa Co.

the fungus have been distributed to several planters throughout the island, who have inoculated some hundreds of mango and other trees attacked by this kind of scale.

(4) It is only about three months since the inoculations were made; therefore it is, I think, too soon to look for definite results.

(5) I have six trees inoculated, including a nutmeg tree, and I cannot say that I have seen any result yet that I can say was due to the inoculation.

(6) Mr. Copland is very keen and enthusiastic over the experiments. The matter is in the hands of the Board of Agriculture of which he is a member.

(7) The scale insect which attacks cacao is not the "lecanium," therefore we are not sure whether the fungus that is being used will attack the cacao scale; but our Superintendent of Agriculture is dealing with the matter, and we expect soon to be able to have something definite to say about it.

(8) Black blight has not, up to the present, done any damage to cacao in Grenada, and it is rare that a cacao tree is seen attacked by scale insects. All the same, the fact of

a few trees being attacked shows that it may spread to an alarming extent if precautionary measures are not adopted to arrest its progress. Our commonest scale in Grenada is the mango scale.

THE TREATMENT OF TROPICAL PLANTS.

By Herbert J. Bult, F.C.S., and Stanley R. Bult.

The subject of the diseases of tropical plants is one which periodically demands close attention from estate owners, and it is encouraging to observe the growing tendency of persons interested in the production of crops to give attention to the scientific aspects of cultivation. Years ago, but not so very many years ago, the opinions offered by scientific men were neglected, or, at the most, given very little attention, but the times have changed, and with them the conditions under which crops are not only produced, but also disposed of; and it has become recognized that unless crop-raising is placed upon a scientific as well as a practical basis by all planters and agriculturists, the more "go-ahead" men are going to

step over those who stick to their old "rule-of-thumb" methods.

In tropical agriculture there is still need for more scientific co-operation, not only in the preliminary work, that is to say, the preparation of lands, and the gathering of the crops, but in addition, and perhaps more especially, it is becoming increasingly necessary in some departments to look after the regular health of the crop-bearing plants or trees.

Rubber is a case in point. It is our firm conviction that unless special precautions are at once taken to thoroughly cleanse land and trees from infectious life, a very serious epidemic will break out in one or more of the rubber-producing districts, possibly being due either to *Fomes semitostus*, a fungous parasite which has lately been found to infest rubber trees, and to cause them to die off, or to *Termes gestroi*, commonly known as the white ant, which bores through the heart of the tree and destroys the living tissue.

The management of the estates, perhaps, is to blame. It is sometimes argued, how are we to know when anything like *Fomes* or *Termes* will attack our trees? We cannot

prevent these attacks. This is true, but it should be obvious that the proper procedure is *not* to treat the disease when it has arrived, but rather by scientific control of the estate to prevent the incursion of the parasite, or, if this is impossible, to make the trees innocuous to the disease.

We have already advocated this in *Tropical Life*,[1] and have roughly indicated the lines on which to proceed. Of this we have more to say later on.

It would, naturally, be the attainment of a highly desirable end, if crops could be sown or planted with a positive certainty of being for ever free from pests and diseases, but unluckily for every one concerned, this end is never likely to be achieved. In the meantime, however, a very great deal might be done, that is *not* done, towards the prevention of disease. In all probability Mr. Hamel Smith deals with the questions involved in the study of this aspect of estate hygiene, and we wish only to record the fact that in Ceylon, where hygiene has been largely practised on rubber

[1] October, 1909; April, 1910.

and other estates, the general health of the trees is better than in districts which have to a greater extent been allowed to look after themselves. A report by Mr. W. T. D. Tudhope, Director of Agriculture, Gold Coast Colony, communicated to the *Journal of the African Society*, reads as follows :—

"The common mistake by natives is in close planting. On the same lines as their food crops, yams, corn and cassava, cacao trees have been placed only 3 to 6 ft. apart. A tree rising 25 to 30 ft. cannot thus produce well. The average is probably not more than 8 ft. . . . Sometimes the cacao is not planted until the farm is about to be abandoned, after having produced foodstuffs for two or three years, and little attention is therefore given it until it is three or four years old, when a vigorous cleaning up and pruning of the trees are undertaken. This is frequently the case when the farmer has undertaken the planting of more cacao than he has the money or labour to look after, and is an evil which would appear to be spreading. These dirty plantations are a source of danger to the whole industry, as the trees, growing weakly, encourage all sorts of diseases, which,

if once fairly established, may be very troublesome to eradicate. Within the last twelve months, an insect pest, fostered under such conditions, has made its appearance and has already done much damage. Its depredations, however, are so far confined to certain districts only, and a vigorous policy of pruning and spraying, already put into operation by the Agricultural Department, has the desired result of destroying this pest, and it is hoped that it may be possible to keep it in check, if not entirely eradicate it. This style of farming, however, must be discouraged."

In a crop like cacao, it is not a good policy to leave the trees untended for any considerable period. You *must* look after them, from the moment they emerge from the surface of the soil, for the cacao tree is one that is particularly susceptible to the attacks of parasitic fungi, and these are almost sure, sooner or later, to make their presence felt, if special precautions are not taken to preserve the trees from their ravages.

Notwithstanding all precautions a more or less severe outbreak of disease is always liable to be transmitted from some neighbouring

estate, or even from some district across the sea, for insects and fungus spores have both been known to travel thousands of miles, from one continent to another. An instance of this is to be found in the Colorado beetle and the potato rot, both of which travelled thousands of miles and spread over immense areas, doing great damage to the crops affected. It then remains for the best man to win, and the best is the one who has paid the greatest attention to the subject of possible disease on his estate, and has prepared himself for an emergency.

There is a greater chance of overcoming both insect and fungus pests if they are taken in hand, so to speak, before they have committed serious ravages, than if they are allowed to go on their way whilst advice and help is being obtained.

Much can be done by the employment of spraying machines and reliable insecticides and fungicides, by careful and systematic pruning and removal of diseased or broken parts, and manuring by the aid of fertilizers adapted to supply those constitutents which have been withdrawn from the land upon which the trees are planted.

As the cacao tree has always been a happy hunting ground for fungous parasitic growths, one of the first points which should be borne in mind by those to whom the care of the trees is given is that the manuring and pruning operations should be under very careful supervision, although regarding the degree to which pruning should be carried widely differing opinions are held. In some instances the trees are almost left to look after themselves, and in others they are pruned to such an extent that it is possible to see right through a plantation.

Air and sunlight, without doubt, exert a very beneficial influence upon the health of the trees, and probably tend in a marked degree to keep down the fungi and the parasitic insects, which are all notorious lovers of damp and shade, but it remains an open question whether pruning may not sometimes be carried too far, and by lowering the vitality of the trees result in reduced and inferior crops.

Then, again in pruning, sufficient care is not always exercised in the manner in which the implements are handled, and if an unlucky gash from a cutlass should cause a prolonged flow of sap, the health of the tree would be impaired.

Almost any crop will respond to improvements in the methods of production. As an instance, some of the rubber collected by the natives, especially in West Africa, is very impure. It is dirty and wet, has a most objectionable smell, and is very liable to contract mould. But skilled white supervision is now gradually improving both the methods of tapping and collecting as well as the resulting rubber, and now that the question of rubber cultivation is of such importance, there is every reason to believe that these rubbers, in an improved form, will, in the future, take a higher place in the open market than they do at the present time.

The ideal at which all planters and estate owners aim, is, of course, an estate of trees so healthy that they are not appreciably affected by the ravages of insects and fungi. Hence, the idea occurred to us of inoculating either the pods, in the case of cacao, or, in other cases, the trees themselves. We are glad to notice that our idea was upheld by G. Hartgrink, who has proved by experiments carried out by him that the injection of ordinary fungicides produces at least a partial immunity

to disease and causes any parasitic insect, that naturally sucks the sap, to die off, the sap being rendered poisonous to the insect. We might mention, regarding this point, that a well-known Dutch firm of insecticide and fungicide manufacturers makes a special preparation for use in this manner and supplies appliances for injecting trees with the preparation with every consignment.

Our own opinion, however, is that the most suitable preparation for fungous diseases is not to be looked for in the general fungicides, but rather in the toxic substances produced by the fungi themselves, or by other fungi.

This is an aspect that has, as far as we know, been advanced only by ourselves, and our reasoning is as follows: In animal diseases, vaccination, or inoculation, by means of certain preparations of bacilli, has the effect of creating the power of resistance to diseases of more serious nature than the one produced by the injected organism itself. As an instance, we may quote the well-known vaccination of children with lymph from a calf suffering from cow-pox, which inoculation causes immunity, either wholly or partially, from the more serious disease, small-pox.

The products which are given off in cow-pox disease increase to such an extent that at a certain stage they become poisonous to the germs of the disease by which they are produced, and so they cause the disease to die out of its own accord. These products are also poisonous to the more serious malady, and can be transferred to other persons, producing similar results.

In the same way the "milk treatment" recently advocated by Professor Metchnikoff, in which the bacilli that produce lactic acid are imbibed into the human system, in milk, has been found to retard, to some extent at least, the action of those germs, which, established and flourishing in the alkaline contents of the colon, set up putrefactive action, the products of which cause bodily decay.

We know that the injection of certain vegetable fungicides into plants and trees results in the circulation of the fungicide with *the sap, which, although not poisonous to the* tree itself, is rendered poisonous to both fungi and insects which normally feed on the sap, and it does not appear to be unreasonable to carry the theory further and propose investi-

RUBBER IN BOLIVIA.
Managing Director, F. J. Dunleavy, and Superintendent, Dr. E. F. Stolzel. In the heart of the Jungle.

gation with preparations of the fungi, for instance, in a specially chosen nutrient fluid.

Miyoshi has proved that saprophytic fungi are capable of penetrating into living plant organs and even of boring through cell walls, if the part be impregnated with a stimulating substance. They behave then completely as parasites, living on the tissues of the host plant.

For instance, *Penicillium glaucum hyphæ* penetrate into living cells of a leaf injected with a 2 per cent. solution of cane sugar, but without this they have never been known to do so.

It is evident, then, that these organisms respond to stimulation, and it would seem only reasonable to suppose that parasitic fungi will also respond in the opposite manner to injections with substances which are poisonous instead of stimulating.

The whole theory is one which deserves close and continued study, carried out, for preference, at the centres of production, although it would be possible for the investigation to be carried out in European countries, providing sufficient funds were available for the purpose.

In the meantime the only course to pursue is to maintain as high a standard of health as possible by the means advocated in other parts of this book.

FUNGI PESTS.

In the issue of May 28, 1910, the *Agricultural News* includes the following remarks in its leading article on :—

THE FUNGI IN RELATION TO AGRICULTURE.

"The fungi form a subdivision of the plant kingdom. The group consists of several thousand species of plants, which differ enormously in size, structure, and complexity. They are grouped together for several reasons, as, for example, the similarity of their vegetative parts, the fact that they are all reproduced by means of spores, and that all of them, without exception, have entirely lost the power of forming chlorophyll—the green colouring matter which occurs in all other plants, with but few exceptions, and without which the plant is unable to elaborate its own food supply from the carbon dioxide and oxygen contained

in the air. For this reason, the fungi may be looked upon as a degenerate group of plants, that is, when regarded from the standpoint of the main path of evolution; in their own line, however, they have attained very considerable complexity in their reproductive arrangements, and also show many and varied forms of adaptation to the manner of life which they have been driven, by different circumstances, to adopt. Members of this large assemblage of plants may be found living under the most various circumstances of temperature and moisture, and with widely different sources of food supply.

"The subject may be further considered at somewhat greater length from a different point of view. Since the fungi are unable to obtain their own food supply from the air, it follows that they must obtain it already manufactured from one or more sources. The only organism that can manufacture its own food supply from the air is the green plant, so that, clearly, one possible source of food for the fungi is the bodies of such plants, either alive or dead; moreover, since animals may be regarded as fundamentally dependent on green plants for

their food supply, their dead or living bodies also offer a possible source of food to the fungi. These are the only available food supplies for these plants.

"As would be naturally expected, all four sources of food, namely, living and dead plants, and living and dead animals, are utilized by different species of fungi. Those fungi which live on dead plants or animals, or on the products of decay of such, are known as saprophytes; while those that obtain their food from living sources are known as parasites. There is an intermediate class, the facultative parasites, which can attack some living plants, or can, if necessary, live on dead vegetable matter.

"Although these are the more technical divisions of the fungi, they may be considered differently in their relation to agriculture. In this connection, there are three points of importance. Firstly, there is the damage that they cause; secondly, the advantages that some of them confer; and lastly, the development of which these advantages are capable.

"Some of the forms that grow on animal and vegetable products—saprophytes—are a source

of annoyance and loss to man, as for example the moulds that grow on grain, bread, cheese, and other eatables, or even on cloth and leather. These may, however, be kept in check without much difficulty. Among the facultative parasites, many species can attack the roots of various economic plants, and even if they do not actually bring about the death of their hosts, they weaken them to such an extent that the value of the crop produced is greatly diminished; moreover, their power of living on decaying remains of these hosts, or even on those of other plants, renders them extremely difficult to eradicate, once they have obtained a hold. Among the class known as parasites, are included all those forms understood by the term "fungus" in its more narrow application. They are, undoubtedly, a source of great loss to all those interested in agriculture, and even when the greater part of the loss can be obviated by the employment of sound preventive measures, the carrying out of such measures involves the expenditure of considerable sums of money.

"On the other hand, many species are of considerable service to man, for several of them

help to destroy old plant and animal remains, and in this way act as scavengers. They may, for example, live on heaps of dead leaves, old tree-stumps, decaying branches, or any other accumulations of rubbish. They often possess the power of secreting enzymes, which can dissolve various forms of organic matter not otherwise easily destructible. The products of their action go to increase the humus content of the soil, often in forms in which they are available to higher plants as a source of food. Such fungi must be regarded as useful, both in their capacity of scavengers and in their function of suppliers of humus products to various crops. Other species can live on harmful fungi, and are useful in this way, while still others are parasitic on various insects of economic importance and are, even under natural conditions, of great importance as a supplementary means of keeping such insects under control.

"The recognition of this last point is of comparatively recent date, and the observations and experiments that have been carried out so far tend to show that it is of primary importance in the control of certain insect pests in

tropical and subtropical climates. The parasitic fungi may be readily encouraged by various means, and under such circumstances afford a way of controlling such pests, which is very much cheaper, and at the same time more effective, in many cases, than any of the artificial methods in common use at the present time. The employment of parasitic fungi in the control of various pests is at present, comparatively speaking, in its infancy, but there can be little doubt that, should this method fulfil, in the future, the promise held out by the results of experiments conducted up to the present time, it will prove of the utmost service to the practical agriculturist."

It has been suggested among planters in the West Indies, if not elsewhere, that the red-podded forastero cacao was less liable, and in fact immune, to fungous pests, which did so much harm to the yellow-podded kinds. This was seen in a report sent into the Jamaica Board of Agriculture, about the middle of 1907, when leave was asked by one of the instructors to visit two estates, to inquire into the supposed immunity of the red-podded forastero cacao from fungus pests, which often

ruined the crop of the yellow-podded trees. The desired permission was given, but with what result I am, unfortunately, not able to say.

The forastero variety of *T. cacao*, Hart tells you, is not immune to disease, but is decidedly less liable to attacks of the various fungous diseases than the criollo, or the *T. pentagona* or alligator cacao. There is no reason however, to show that immune varieties cannot be found if sought for, or cannot be raised if semi-immune varieties are used as the parents.

It is generally accepted now in Jamaica, writes Mr. Cradwick, that the red-podded varieties of forastero are more hardy in every way than the yellow-podded varieties. On this account the Agricultural Department there distributes seeds or plants of no other kinds, and only estate owners plant others. The red pods do not suffer from pod rot to anything like the extent that the yellow ones do. The variety which is of a pale silvery tint when young, and bright yellow when ripe, bears beautifully, but suffers terribly from rot, so much so that you meet with trees crowded with pods, none of which ripen properly on account of the disease.

PESTS OR GENERAL PESTS
(NOT SPECIFIED.)

It is wonderful how firms, who ought to know better, still want to insist that *Termes gestroi* are an advantage to an estate, and not a pest. Quite recently I received a letter from a large firm of insecticide makers, which practically told me, when I urged the absolute necessity of co-operative action to destroy the termites, that I did not know what I was writing about. Reports from the East show that the pest attacks both hevea and rambong trees most virulently.

In spite of this, I have heard it stated, by men of the greatest experience, men who have been on the spot in the East for years, that the trouble with white ants is dying out on the estates. Reports from the Government entomologist do not point to this. Properly kept estates, it is claimed, can soon rid themselves of the pest, which only comes for a few years after the forest or high bush is felled. This in theory is correct; but then, since the termites attack the rubber trees, much harm, irreparable harm, can be done to the planta-

tion, even in the few years during which the stumps are rotting away.[1] Then, again, very large areas have to be cleared, and do what they will, and obtain all the labour that it is possible to obtain, these areas will not be planted up in twenty, or even forty, years. One can therefore safely reckon on having the *Termes gestroi* to fight against for at least that period. I feel, therefore, that it will still be as well to try and kill out, or keep down, the ants as much as possible, and not wait for them to die out. As I point out elsewhere, all the estates are not properly kept, and unless legislation steps in, as I ask for in my preface, there will always be badly kept estates, to breed ants and other troubles. Those, therefore, who seem to be advocating a *laisser-faire* line of action, with the idea that the white ant trouble is not worth troubling about and will die out, will find out in the end that they have made a very serious mistake.

It has been shown, I am told, that the ants

---

[1] For the moment I am leaving the matter of the root-fungus trouble out of the question.

return to the same feeding ground, or piece of wood, over and over again, because fresh supplies of mycelium reappear after the first is eaten off.

The Colonial Office Committee, which was recently appointed by the Earl of Crewe to further the study of economic entomology, with special reference to Africa, has already made a beginning. Two trained entomologists have been engaged — Mr. S. A. Neave on the East Coast, and Mr. Simpson on the West in Southern Nigeria — in stimulating official and other residents in the collection and observation of harmful insects, and in imparting instruction. Mr. Neave proposes to proceed from the East Coast through Nyasaland, and both will from time to time forward collections to this country.

Already a collection of insects has been received at the Colonial Office from Portuguese East Africa, and other countries, having possessions in that continent will, it is hoped, follow this example.

CACAO DISEASES AND PESTS.

WITH regard to the black or brown rot (*Phytophthora omnivora*) that has attacked San Thomé, owing to the lack of cultivation, and overshading, it is worth noting that even with those pods or seeds which escape the disease a loss can still be sustained. Hinchley Harts reports that experiments made with beans from diseased (black rot) and healthy pods, fermented and cured in a similar manner, gave the following results: Whilst 432 beans from healthy pods were found to go to 1 lb., it took 565 beans from diseased pods to make up that weight. Affected pods, therefore, whilst giving a cacao inferior in every way, also show a loss of over 25 per cent. in weight to the planter.

Trinidad authorities, some time ago, spoke of the "brown rot" disease as attacking Cacao, Dadap (*Erythrina*), Tea, Castilloa, Hevea, and Caravonica cotton. It seldom kills out more than one plant, but it attacks practically every-

thing. It can always be distinguished by the thick coating of sand and stones which adheres to the mycelium on the root. It appears to begin on pieces of wood in the soil, and it does not spread to other trees unless the roots are in actual contact. If a tree is taken out as soon as it is dead, practically the whole of the fungus is removed. In spite of its frequent occurrence I have not been able to obtain the fructification in the field, nor to produce it under cultivation, though specimens have always been under observation during the last two years. It appears to be identical with the mycelium attributed to *Hymenochæte* in Samoa and to *Sporotrichum* in Java; and it is probably the same as the *Irpex flavus* of coffee. Hevea is more often attacked when planted amongst cacao, or in old cleared cacao land. Like all other dead trees, they should be removed as soon as they are dead. An instance illustrating this—and the non-appearance of the fructification under most favourable conditions—may be cited. Hevea was planted in a single row, 14 ft. apart, twelve years ago. Four years ago a tree died, and the stump was left; two years later the next tree died,

and was not removed; in the present year the next in the row began to die. Thus it was possible to examine a tree just dying, a stump, 10 ft. high, which had stood two years, and an old stump in the last stages of decay; but no sign of a fructification was found. In all these cases the roots of one tree had advanced across the roots and beyond the trunk of the next.

"Brown pod disease" seems to have been rather more prevalent during the last season. In many cases spraying has not yet been adopted, and in others it is begun too late. It must be remembered that *spraying is not a curative but a preventive measure, and must be carried out systematically to be of any use.* The pod disease of Ceylon appears to be due to *Phytophthora*, but whether *P. omnivora*, de Bary is doubtful, as the germination of the conidia has not been observed—a difficulty which appears to have been experienced by investigators in other countries also. The same fungus occurs on the fruits of Hevea and breadfruit. (See also Rorer's results on cacao spraying in Trinidad: *Bulletin*, Department Agriculture, Trinidad, vol. ix., No. 64.)

Mr. F. A. Stockdale (British Guiana) very rightly points out that the recent work of Rorer in Trinidad, regarding plant diseases, is worthy of the serious attention of all interested in tropical planting. His examination of the life-history of *Phytophthora* is an excellent piece of work, and may modify our ideas somewhat in regard to canker on cacao trees. He was afforded the opportunity of making a thorough and continuous study on the spot of the chief diseases in cacao in Trinidad, and has made very good progress in the work.

According to Hart the present treatment of "canker" is effectual, the scientific knowledge of the disease *leaves much unexplained*, and it seems evident, from the varying accounts of what is apparently the same disease, in different countries, that there is still room for additional investigation. In the West Indies the stem disease is attributed to *Calonectria flavida*, Mass., and *Nectria theobroma*, Mass., while the pod disease is referred to *Diplodia cacaoicola*, Henn., and *Phytophthora omnivora*, de Bary. From Java, Zimmermann records *Nectria coffeicola*, Zimm., and *Nectria striatospora*, Zimm., on cacao stems; and *Calonectria*

cremea, Zimm., and *Colletotrichum incarnatum*, Zimm., on cacao pods. In South America *Calonectria bahiensis*, Hempel, is found on the stem. In the Cameroons *Colletotrichum incarnatum*, Zimm., *Phytophthora omnivora*, and *Eunectria camerunensis*, Appel and Strunk, are recorded, while Dr. W. Busse states that Phytophthora occurs on the bark, and can attack the fruit from there. The position in Ceylon may be summarized as follows :—

(1) A disease attacking the pod may work through the peduncle into the stem.

(2) The stem may become diseased quite independently of any pod disease.

(3) The first fact has led to the belief that the stem and pod diseases are identical, both being due to a *Nectria*.[1]

(4) The fungi on diseased pods are *Phytophthora*, sp., and *Collectotrichum incarnatum* always; and rarely a *Diplodia* and a *Dialonectria* not identical with any of the species enumerated above. This *Nectria* also occurs on Panax killed by *Rosellinia*.

[1] Mr. Rorer, the mycologist in Trinidad, has, according to Hart, shown that *Phytophthora* will cause canker, and argues that he can only find *Nectria* is the portion of a *saprophyte*.

(5) The *Nectria* on the stem is not the same as the *Nectria* on the pods. The former agrees with *Nectria striatospora*, Zimm. It is perhaps the commonest Ceylon *Nectria*, and has been found on tea killed by *Massaria theicola*, tea with branch canker, felled albizzia, dead *Derris dalbergioides*, &c.

Speaking of canker on cacao trees, my friend, Mr. W. Malins Smith, the well-known planting expert of Grenada, in his address before the Agricultural Society of that island also urged the authorities to see that individual planters should be taught to stamp out disease on their estates so as to keep the island, as a whole, as free as possible from pests.

In a book that he is publishing on cacao cultivation, this authority expresses the opinion that commercial fertilizers containing at least 15 per cent. of lime always give better results than those which do not contain lime in any appreciable quantity. He says that it is wise to apply a good dressing of lime to the soil at least six months before manuring. The lime sweetens the soil, breaks up heavy clay and brings the soil into a good condition to receive the manure, to the advantage of the cacao trees.

The regular "bedding" or burying of all empty pods, dead leaves, weedings, &c., adds much to the sanitation of the cacao field, in addition to increasing the condition and fertility of the soil.

Mr. Malins Smith is also strongly urging that, in order to keep cacao fields in a sanitary condition, attention be specially directed towards: proper drainage, so that no dormant moisture is permitted in the soil; proper tillage, which includes forking and the burying of all refuse matter which may be in the field; the proper treatment of the soil for root disease; the burial or removal from the field of pod-shells; the burial with lime or the burning of all diseased pods; the proper treatment of all diseases; care in removing suckers, in pruning, in excising canker, and in picking cacao so as not to wound the tree unnecessarily; the proper treatment of all wounds; repairing old wounds and removing all dead wood and dead branches from the trees; protection of the trees or the field from wind; reduction of dense overhead shade, and the destruction of all shade trees attacked by disease or scale insects.

In his remarks he said: "There are two kinds of canker which attack the cacao tree in Grenada—the 'root canker' and the 'stem canker.'

"The root canker is the more dangerous disease, for the reason that it works underground and out of sight, and kills the trees before its presence is detected. It usually starts on a single tree and, if preventative measures are not taken immediately, when that tree dies, it may spread to the adjacent trees by contact of the roots.

"So long as the roots of a diseased tree are in direct contact with the roots of the adjacent trees, there is no limit to the spread of the diseased area.

"Every planter should examine his trees carefully to ascertain definitely to what extent the damage has already progressed. The peasant proprietors have a considerable amount of it on their small holdings and the authorities should make it one of their special duties to show it to them, and teach them how to combat this disease.

"In dealing with root canker the first difficulty to overcome is to be able to recognize the disease.

RUBBER IN BOLIVIA.

Turning Latex into Rubber by the Smoking Process, as carried out in the Bolivian-Amazon Centres.

"This is a greater difficulty than it may appear to be, for there are few planters in Grenada who know anything much about canker.

"Immediately that a cocoa tree dies, the roots should be examined. If the tree has died from root canker, the bark and wood of the roots near to the stem will be of a claret colour and show signs of decay.

"The disease cannot be cured, but preventative measures must be taken so that it does not spread to the adjacent trees.

"At this stage the disease may already have spread from the roots of the dead tree to those of the adjacent trees; but it is not likely that it has worked very far up from the ends of the roots. A trench must be dug, completely encircling the spot where the dead tree was growing, thereby isolating as wide an area as will include not only the extreme root-ends of the dead tree, but also about 2 ft. of the root-ends of the adjacent trees.

"In digging the trench every root encountered must be cut through clean, and the cut ends examined to determine whether the claret-

coloured disease has spread beyond the confines of the trench.[1]

"The trench must be at least $1\frac{1}{2}$ ft. in depth and may be filled up after six months.

"Every root within the isolated area must be dug up and burnt along with the stem and branches of the dead tree.

"The isolated area must be deeply forked and a heavy dressing of lime applied to it. Six months later a "supply" may be planted to take the place of the dead tree.

"These preventative measures apply not only to cases where single trees die off, but also to wider areas where the disease has spread considerably before the planter has realized that root canker is damaging his field.

"The stem canker of the cacao tree, though not so destructive in its direct effects, is, I believe, quite as destructive indirectly that

[1] With root disease in Hevea, this, according to Mr. Gallagher, is not sufficient. "Digging a trench only," he says, "is no use; the dead roots of the diseased tree are, it is true, inside the trench, but, at least with Hevea, the roots of the healthy trees around will soon grow, *underneath*, to within the diseased area and become contaminated if all the infected area is not dug over, and all the wood (roots, &c.) removed. If this is done, then there is no need to dig a trench."

is, in its effects on the yield of the trees attacked.

"I believe with Mr. Barrett that stem canker not only restricts the flow of the sap current, but also poisons it, thereby causing the loss of a considerable number of pods which might otherwise have come to maturity.

"Stem canker is not easily detected unless special search is made for it. It is generally found on the stem and main branches at a height of not more than 8 ft. from the ground. It is localized by means of a dark reddish spot the size of ½ in. to 2 in. in diameter which appears on the bark; this has the appearance of a burnt spot. Notwithstanding that this spot is so small, the disease may have made considerable progress along the cambium layer between the bark and the wood.

"It is interesting to note that the more rapid progress of the disease is invariably in a vertical direction, or I should say in the direction of the flow of the sap.

"The remedial measures that must be adopted are excision and burning of the chips.

"In cutting out canker from the stem of a cacao tree it is not necessary that more

than $\frac{1}{2}$ in. beyond the diseased area should be removed. The diseased area is easily distinguished by its claret colour. All dead wood around the diseased spot should also be cut out.

"The cutlass should not be used for excising canker, for the reason that it cuts out a most unnecessary quantity of healthy bark and wood, thereby weakening the stem and causing a very great loss of tissue to the tree.

"The most convenient tool to use is a chisel, a gouge chisel in preference to a flat one.

"Every particle of bark and wood that is cut out must be carefully collected and burnt.

"After the diseased area has been cut out, the wound must be carefully dressed with an antiseptic and preservative, such as coal tar or resin oil, or a mixture of both, in proportions of one of the former to four of the latter. The outfit for excising canker should consist of two or three chisels of various sizes ($\frac{3}{4}$ in. to $1\frac{1}{2}$ in,), one being flat, a small mallet, a small pruning knife, a pot of antiseptic dressing, and a brush.

"In searching for canker it is quite useless to merely walk through the field and trust to the chance of the eyes alighting on a canker spot.

Each cacao tree must be carefully examined from the base of the stem to about 10 ft. in height.

"There are other preventative measures that should be adopted if canker is to be kept away from the cacao field, and these are what is known as field sanitation.

"The field should be properly drained. No water should be allowed to rest in any part of it.

"All empty pods should be disposed of by burying, covering, or removal from the field. All wounds made on the tree either in pruning, removing suckers, picking, or otherwise, should be dressed immediately with some antiseptic.

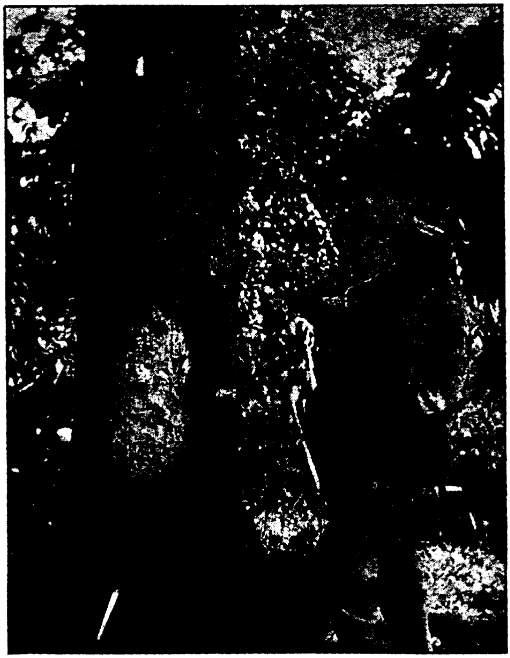
"Only careful and patient workmen should be deputed to carry out the operation of excising canker, so as to ensure that it is properly done.

"The cacao fields of Ceylon were very seriously attacked by canker some years ago. Remedial and preventative measures were commenced and vigorously carried on with immense benefit to the fields, and increase of crop as the result. In Grenada there is more canker in the cacao fields than the planters believe, and before it gets to the serious stage it should be eradicated."

Root diseases of cacao still require classification from all accounts, and attention should be given to other trees on the estate where root disease has broken out. It will be of little use to attend only to cacao trees if the trouble is coming from fruit or coffee trees, planted for ornament, or to furnish the house with supplies.

Mr. F. A. Stockdale has given a good deal of information on the matter of root disease, but does not make it clear as to the name. In Samoa and Ceylon, he tells us, it has been attributed to *Hymenochæte*, and in Java to *Sporotrichum*. On the other hand, we are told that it comes from the bread-fruit, whose root disease has been classified as *Dematophora*, or *Rosellinea*. Another point to note is, that cacao root disease, like rubber in the East, is fairly prevalent in cacao fields planted on freshly cleared forest lands, and the fungus may have originated in the rotting wood left about. Mr. Stockdale recommends that badly diseased trees should be taken out, their roots extracted, and the whole burned. In less serious cases, the soil can be removed from, and the principal roots laid bare. The diseased roots should be pruned, and the affected parts

removed and burned (see elsewhere for root pruning). For such cases basic slag would,



RUBBER IN BOLIVIA.
Emptying Latex from Tichuela (Small Tin Cup).

probably, be found of great use, as a good application of lime—say 5 lb.—we are told should be placed in the holes made in baring

the roots, and the soil even quicklimed. Those against ploughing or forking complain, and with justice, that wounds in the roots render the trees very liable to pick up root diseases through such wounds.

Be this as it may, the ground, if the planter wishes to be permanently quit of the disease, *must be cultivated* either by forking or other means, and if the soil is so full of fungus that the bruised roots pick it up, I would maintain, that if the roots be allowed to remain perfect through lack of cultivation, it would be the worse of the two evils. Better to give the tree its only chance of throwing off the disease by opening up the soil, than to be afraid of the trees being more liable to pick up the disease owing to damaged roots. Meanwhile, Mr. Stockdale and others have proved that, in the case of root or other diseases, too much attention cannot be given to careful and thorough cultivation. "Results obtained on the experiment plots of the Imperial Department of Agriculture in the various West India Islands have shown that high cultivation and judicious manuring are followed by the best returns. Expenditure on tillage, drainage,

and manures is followed by increased profits, and the vigour and health of the trees are improved."[1] For the supply of humus for cacao estates it may be found necessary in some localities to set aside areas on the estates for the growing of grasses, or leguminous crops, that may be used on the plantations either as mulch or in the form of pen manure.[2] It has frequently been observed by scientific workers, the *West Indian Bulletin* goes on to tell us: "That when conditions of soil or climate are such as to interfere with vigorous and healthy growth, changes may take place in the tissues of the host plant which may favour the development of the fungus, and encourage its spread." Healthy development may, on the other hand, assist the plant to resist fungus and other disease, or, if it comes, to throw it off before it can get a firm hold of the tree.

If, therefore, tillage, drainage, and manures encourage healthy development and vigorous growth in the trees, forking or ploughing must be resorted to; otherwise where does the tillage

---

[1] *West Indian Bulletin*, vol. ix., No. 2, p. 184.

[2] I recommend the same in the "Future of Cacao-planting."

come in?—since tillage is the cultivation, *i.e.*, the digging and breaking up of the ground, which the Imperial Department tells us is necessary, together with adequate drainage and manuring, if the trees are to yield their best, and which, as shown above, gives increased profits when carried out.

The case of the witch-broom disease in Surinam shows two things very prominently: (1) what havoc a deeply rooted disease can cause in a centre largely dependent on a single crop; (2) what a long time a disease can be in our midst, slowly but surely taking a firm grip of the trees, before we are even aware of its presence, much less before we have realized the danger.

"It is conclusively proved," reports Dr. Van Hall,[1] "that the spread of the disease is slow, and many years must pass before it would reach such proportions that the damage caused could be felt by the estates. It must have been present long before it began to attract attention,

[1] Translation of the "Report on the Surinam Witch-broom Disease, by Van Hall and Droost," in the *Proceedings of the Trinidad Agricultural Society*, December, 1909.

and witch-brooms must have been produced for a considerable time before any notice was taken of them, and it was only when it became clear that a dangerous disease was at hand that serious consideration was vouchsafed them. A similar course of events is unfortunately to be noted in connection with other plant diseases."

Writing on this matter, Mr. Stockdale, in the neighbouring centre of British Guiana, says: "The treatment of witch-broom in Surinam is only just beginning. It has been shown to be capable of being combated experimentally, but practically no planter has yet taken the matter up. One estate has been completely treated, and a few others are now obtaining loans from the Government to assist them in treating some, if not all, of their cultivations. Other estates have seen the advantage of good cultivation and drainage, which was practised at the same time as topping and spraying by Dr. Van Hall, and their owners appear to be satisfied with the increased yields, although the disease is still fairly common. Witch-broom disease weakens the trees, but it is maintained that it can be fought by other methods—topping and spraying. The rational treatment of disease is

what is required in the case of witch-broom, with its aid the disease could be reduced to a minimum. I have persuaded one or two of the larger estates in this colony to adopt remedial measures for witch-broom, but it is difficult to get them to maintain strict control. See my notes on "A Visit to Surinam" in the *Journal of the Board of Agriculture*, British Guiana, vol. iv., No. 1.

Everyone, I am sure, will agree that the way Holland attacked the witch-broom disease, when official attention was called to it, is deserving of all praise; but nowadays something would have been done in an earlier stage of the trouble to have prevented so serious a loss to the community as it occasioned. Had not the Surinam cacao lands been isolated; had they been nearer to Demerara, Trinidad, or other producing centres, through which the disease could have spread, the trouble would have assumed terrible consequences. Think of what it would mean had the disease broken out with the same proportionate virulence in Guayaquil, San Thomé, Bahia, or our own Gold Coast. In these centres you have ten and twenty times the output and number of trees that you

have in Surinam, which had its production reduced from 38,600 bags in 1899 to only 8,540 bags in 1904. This shows a loss, therefore, of 75 per cent. in five years. Realize the money lost to Surinam through the disease, and what it would have been worth while spending in cultivation, manures, spraying machines and fluid, to have prevented the disease from spreading at the start, had the planters realized what was going to happen. Think also what it would mean, not only to the planters in the producing centres, but also to the cacao manufacturers and the allied trades dependent on them in Europe and America, if the cacao exports from such centres as Guayaquil, Bahia, San Thomé, &c., or our own colony of the Gold Coast, had fallen off in a corresponding degree during the past five years. Bahia this year (1910) will probably produce half a million bags, and since 1904 (*i.e.*, during 1905-1909) has exported 2,200,000 bags. It is true that just now all the manufacturers are well supplied with cacao, but this would not have been the case if the Bahia output had been rapidly decreasing, instead of steadily increasing since 1904, and was likely to export only 100,000 bags, instead of 500,000 as we

expect from there. Bahia had a bad attack of die-back some years ago, but this did not seriously affect the output, although it caused a good deal of anxiety at the time. But it made one realize, however, that the same as with Surinam, if, when the country was first opened up for planting, danger belts of the original forest trees had been left to every five or even every ten miles of cacao land, it would have enabled both centres to have restricted the areas of the mischief, whilst stamping it out. Had the authorities in Surinam, between 1896 and 1899, when the reduction in the output of certain lands first gave indications of trouble, been able to confine the outbreak to this area, until the disease broke out in full force and enabled the scientists to study it and apply remedies, the country would not have had to suffer throughout before relief came. The lesson that cannot be taken too much to heart over the Surinam disease, is the great loss that can originate perhaps on a peasant proprietor's acre or two of holding, and from thence pass unnoticed and unknown[1]

[1] See *Trinidad Agricultural Proceedings*, December, 1909, pp. 481-2.

right through the producing centre, like the Black Plague did among human beings in the old days. This shows how absolutely

CACAO IN SURINAM.
Pruning and Cutting Back a Cacao Tree affected with Witch-broom Disease.

necessary it is that the question of pest extermination and elimination be made a matter for the various governments to take up, with a view of its being put in all ways on an inter-

national basis. Even to-day, Dr. Van Hall, speaking of the witch-broom disease, tells you that "we are convinced that the witch-broom disease will not disappear unless effective measures are taken (*i.e.*, by the best Dutch scientific men) to expel it." If the disease can prove so troublesome in the hands of such men as Van Hall or Drost, think what can happen when only practical but unscientific rubber or cacao planters find a bad outbreak on their lands.

After many experiments carried out to ascertain the best method for ridding the estates of the disease, it was decided that the surest remedy would be to remove *en masse* the affected part. The entire leaf-bearing crowns were therefore pruned off, so that nothing remained but the trunk and leafless main branches. I am able to give illustrations of this operation, thanks to the figures included in the Trinidad Society's book, published by the courtesy of the Netherlands Botanical Society.

It is important here to note that on the West Coast of Africa the white ants are also giving trouble to the cacao trees; whether they are

Spraying a Cacao Tree after Heavy Pruning, to cure Witch-broom Disease.

also giving trouble to the rubber it did not come within the province of my friend to ascertain. Regarding cacao, however, we are told: "It is termites or white ants that really do most damage to cacao trees in this country. Once they gain admittance to a tree, unless attention is paid to them, the tree is bound to die before long. You must all know these small white insects that build little tunnels of earth up the trunks of your trees. If you break off a dead dry branch you will find them in swarms inside. The insects live under the ground where they move along until they come to a cacao tree; being blind they never appear in the light, but keep out of harm from birds and other insects which feed on them, by building the tunnels up the trees and climbing up under the shelter of them.[1]

"In order to save your trees from being killed by termites, you must remember and pay attention to the following points: (1) When pruning always use a sharp instrument

[1] Hart (and I believe others) maintains that white ants live upon the mycelium of fungi, and that no tree is attacked unless it is permeated by mycelium, although the latter may not always be visible to the naked eye.

which will make a clean cut, and cover the exposed surface with tar. (2) Apply tar to all holes made by borers and any accidental wound made on the trees. (3) Remove all dead wood from trees and burn it. Cut right down to where the wood is healthy, and apply tar, or coal tar and resin oil if preferred. (4) Have all the earthen tunnels brushed off from the trunks as soon as you see them being formed. (5) Do not let a lot of dead stumps and logs be about in your plantation, and attend to all wounds on shade and other trees, &c., that happen to be growing in your cacao plantation, in the same way as recommended for your cacao trees."

"It is very important that everything should be done to make your trees healthy and strong; they will then be much more likely to escape attack from insects. (1) Do not plant your trees too closely together, they should be 15 ft. apart from one another.[1] (2) Do not let more than one main stem arise from the ground. If your young trees are sending up two or three main stems, judge which is the strongest and prune

[1] The better the soil the more vigorous will the trees become, and hence the further apart can they be planted.

off the others, being careful to tar the wounds. (3) Finally, keep your trees properly[1] pruned, so that they may get sufficient light and air. (4) If labour is scarce, it is better only to have as many trees as you can look after properly, and to keep them clean and healthy, than to have so many that you cannot attend to them properly, otherwise the latter are certain to become diseased, short-lived, and to serve as centres for the spread of disease."

Mr. Stockdale asks that this point should not be pressed too strongly. "If," he tells us, "the trees are not planted too closely together, two or three stems are often an advantage. On Mr. Bain's estate in Trinidad, the policy of allowing two or three stems has been adopted with satisfactory results. It is a common method in Ceylon, and can be recommended when renewing old cacao. At Onderneeming Station, in very old trees we have encouraged two or three good suckers, topped them at the proper height and then cut out the old wood."

It is on account of our Gold Coast Colony as much and perhaps more than any other

[1] "Properly" is an important word here; some pruning is so roughly done, that it permanently damages the trees.

centre that I am anxious to see some form of international, or at least inter-colonial, action adopted in regard to taking mutual precautions for preventing pests and disease from spreading among the trees; so that if, by bad luck or bad management, trouble appears on an estate, it at once receives attention and is not allowed to spread.

At first, I believe, the Gold Coast was fairly fortunate in regard to pests, either with cacao or rubber. This was due, no doubt, in some degree to the care that Mr. A. E. Evans took when Mr. W. H. Johnson's resignation of the directorate made him Acting-Director for a good many months, and the precautions he is now exercising as travelling instructor to keep the estates free of disease. Mr. Evans has always been, like Prof. Carmody and Mr. Hinchley Hart, of Trinidad, and Dr. Willis, of Ceylon, a strong believer in the proverb of "a stitch in time saves nine" with regard to spraying and attention to the trees, *before* trouble comes.[1] Far better have your spraying

[1] For rubber trees, coco-nuts, &c., and even for cacao trees, a power-driven sprayer is necessary, say a 3-h.p. engine with four sprays, to be worked with petrol,

machine, like a fire engine, ready for emergency, than to wait until the pests come and fire breaks out, before writing or wiring over to England for a machine. Latterly, however, in spite of Mr. Tudhope's (the present Director of Agriculture) care and Mr. Evans's advice, pests and disease are giving trouble, and will continue to do so to an increasing extent if spraying and other precautions are not resorted to. *Hymenochæte* is undoubtedly to be found there, and also *Botrydiplodia theobromæ* and possibly *Fomes semitostus.* On this account several of the leading makers of spraying machines here and in America promised, at my suggestion, to send samples of their apparatus out to the Coast, and so give the estates there a fair chance of experimenting with the best class of sprayer, and being able to realize the advantages of using them. I hope, therefore, that the Gold Coast will be able to keep their estates free from trouble. Last year they had rather a bad attack of insects and fungus

not oil; the probable cost of such a machine should be about £130. "I know," writes Mr. Gallagher, "from experience that oil is not advisable for such work, as 'a continuous flame' ignition is not wanted."

pest, but, as the Agricultural Department are all well aware of the necessity of treating this at once, and believe in "nipping the evil in the bud," the trouble should be kept within bounds, if the officials of the Agricultural Department are supported by the estate owners when issuing instructions and suggestions to fight the diseases.

"The chiefs on the Gold Coast," Mr. Tudhope tells us, "have of late been interesting themselves very much in the work of the Agricultural Department, and if we are able to get their hearty co-operation, as well as that of their followers, it should be possible to effect a marked improvement in the quality of the rubber produced (Funtumia) in the course of a few years, and a considerable increase also in the quantity exported. In European countries and in America, one of the aims of an Agricultural Department is to experiment, to educate, and to advise farmers, thus assisting them to produce large and good crops, which, for the most part, are grown for home consumption. The aims of a tropical Agricultural Department are similar, with this difference, that, to be economically successful, those crops

which produce articles for export receive most attention. In the Gold Coast that is doubly true; we have here to deal with a native population that is only now beginning to appreciate the advantages of civilization; a population fairly well off, that is not too numerous in a naturally rich country."

"Beginning to appreciate the advantage of civilization," and also of the Agricultural Department leads one to hope that the authorities will be able to get "behind the black man's mind," and prove to him before it is too late that his cacao and rubber estates cannot be kept free from disease unless cultivation and spraying are freely and systematically carried on. The Report issued by the Agricultural Department of the Gold Coast for 1909 shows what a busy, as well as an anxious time, Mr. Tudhope and his staff have had.

Before I leave the Gold Coast, and go on to another centre, I would like to call your attention to the progress that the cacao and Pará rubber-planting industries have made there, partly taken from the last report, but with the cacao exports since 1891 included. The rapidity with which the exports of cacao have

By courtesy of the African Rubber Co., Ltd.

3½-YEAR-OLD CACAO TREE, PLANTED WITH PARÁ RUBBER NEAR AXIM (WEST COAST AFRICA).

increased is of course well known. The natives have taken kindly to the industry and plantations are still being extended. In 1895 only 28,906 lb. were exported, in 1891 it was only 80 lb.[1] I believe if disease or other serious trouble does not give the industry a temporary set-back, that in ten years time, *i.e.*, 1920, the Gold Coast will be one of the chief, if not the chief producing cacao centre of the world. It is therefore well worth studying to see how it attains so important a position, and how it will manage to free itself from the diseases and insect pests that have appeared.

[1] Year	Cacao, lb.	Rubber, lb.
1891	80	—
1892	240	—
1893	3,460	—
1894	20,312	—
1895	28,906	—
1896	86,854	—
1897	156,672	—
1898	414,201	—
1899	714,929	5,572,554
1900	1,200,794	3,452,440
1901	2,195,571	1,520,009
1902	5,367,405	1,599,974
1903	5,104,761	2,258,981
1904	11,451,458	4,013,837
1905	11,407,608	3,633,106
1906	20,104,504	3,649,668
1907	20,956,400	3,549,548
1908	28,545,910	1,773,248
1909	45,277,608	2,764,190

To the cacao-producing world generally, the Gold Coast demands attention. This is for two or three important reasons: (1) The production is entirely in native hands, and

AN OLD FRIEND OF WEST AFRICA.
The late Sir Alfred Jones, K.C.M.G., at home, near Liverpool.

the producers would probably be satisfied, should prices fall, with a lower price than any other centre could accept. (2) If the natives are able to keep their estates free of disease they seem likely to be able to obtain

a heavier yield per tree than elsewhere, and at a lower cost. (3) The centre could be made to turn out practically any quantity of cacao that the market requires, and its ability to produce this at a minimum of cost, should cause all other centres to be warned in time, and take care that they increase their yield per tree as quickly as possible. It costs less to gather 6 lb. from one tree than 1 lb. from each of six trees, or ½ lb. from twelve, and as other centres will probably be unable to produce, even 3 lb. per tree, as cheaply or with as low a margin of profit as the Gold Coast man would be satisfied with, planters elsewhere must see that economies on their estates are practised in every possible department. This can only be done by applying common-sense and science to make up for the cheapness and large returns on the Gold Coast.

The introduction of cacao to the Gold Coast only dates back to about 1882, and after twenty-six years' cultivation the export of the product attained a total of 45,277,608 lb. last year. In studying these figures one must not forget that this has been entirely produced by native farmers, and I consider that the

results so far attained are highly creditable to the enterprise and industry of the indigenous population. The quality of the product, in comparison with that of most other cacao producing countries, is generally speaking poor. There are several causes contributing to this: (*a*) It is an industry new to the natives, and consequently they have not yet been educated in the proper methods of cultivation and preparation; (*b*) the variety of tree grown (Forastero, amelonado variety) is generally recognized as bearing a second-grade quality of beans even when grown under the most favourable conditions; (*c*) the natives are entirely dependent on the sun for drying the beans, and in a country like this, where the atmosphere is very humid, mould forms on the beans very readily in dull weather; (*d*) all qualities (with the exception of the very worst) have hitherto been bought at a uniform price.

The Agricultural Department is naturally concerned with the improvement of the quality of cacao. Travelling instructors have already done a lot of good work, lecturing and giving practical demonstrations on the plantations, but, owing to the shortage of competent

officers, all that could be wished for has, by no means, been effected. The variety grown, although recognized as yielding only a second-grade quality of cacao, is hardy and very fruitful and, therefore, in my opinion, well suited for native cultivation. A few plants of three other varieties have been introduced by the Agricultural Department, but the results so far obtained have not been such as would recommend their more extensive cultivation to the exclusion of that at present grown. I hope, however, to see experimental areas of the more important varieties put down at each of the agricultural stations, so that this point may be settled.

That cacao can be made to yield well in the Colony is amply illustrated by the fact that on the Aburi Botanic Gardens from a small area of 1⅗ acres and from 259 trees planted at 15 by 15 ft., a yield of 18,200 pods, equivalent to 15 cwt. of cured cacao, or 6½ lb. per tree, was procured between October 23 and December 31 of the year 1908—*i.e.*, in sixty-nine days only. Further, I am informed that a considerable crop was taken in the earlier part of this year of which no record was kept; and the

trees are now giving promise of an early crop in 1909.

The quality of the soil on which these trees are growing is distinctly below the average of the Colony; but, be it noted, this heavy yield was probably due in a considerable degree to the careful and systematic way in which the trees had been well pruned and attended to.

According to Ballou, carbon bisulphide may be used for the destruction of borers in the trunks of trees by injecting small quantities of it into the tunnels of these insects, care being taken to distinguish tunnels from which the insects have already escaped, since it would be a waste of material to apply the chemical to such holes. Tunnels in which the grubs are still to be found can be distinguished by the quantity of chips and excrement, and sometimes by gummy exudations, which indicate their mouths. Clean holes point to the insect having escaped, but in the holes still containing insects a small quantity of carbon bisulphide into the tunnels will cause the death of the grub. The same chemical can be used for the destruction of ants by pouring 1 or 2 oz.

of the liquid into several holes made with a wooden or iron rod.

Mr. Ballou, however, warns us that in using carbon bisulphide, the direct contact of it with the roots of plants is sometimes injurious, but when applied in comparatively small doses at a little distance from the plant there is generally no ill-effect.

What I believe we shall some day see established on tropical estates will be a system of insect, if not fungus, destruction by means of sulphurous and other gases and fumes. Had it not been for the difficulty of application such a system would probably have already been introduced, but as it seems necessary to enclose the articles to be fumigated in a box or wrapping, the process does not as yet appeal to the planter. Where I look for a possibility of using it, would be to place a cup made of rubber or other material against the part of the tree affected in such a way that it could, by exhausting the air, be made to adhere sufficiently to allow that portion only to be treated, and then other spots in turn. If we can overcome the trouble of applying the gas, one like sulphur dioxide (SO_2), for instance,

certain death should accrue to insects. I also believe canker, witch-brooms, &c., cacao and coco-nut beetles, ants, &c., could be disposed of by such means. I say this because, although SO_2 gas is fatal to plant life in the ordinary way, I believe that certain spots or places on the bark of the trees could be treated along the lines suggested without injuring the tree itself.

Very exhaustive experiments, carried out by Mr. J. Wade in 1905-06 for the Local Government Board, showed that in a model ship's hold, stowed with a general cargo (quoting Mr. Wade's report), "rats and insects would be destroyed in less than two hours by the uniform diffusion of, at most, 0·5 per cent. of sulphur dioxide. This condition is easily and quickly realized in cabins and empty holds, and in the space around the cargo in a loaded hold; but owing to the extensive absorption of this gas, air containing 3 per cent. of it must be circulated around the cargo for eight to twelve hours to ensure adequate penetration.

"Pathogenic bacteria in exposed places would also be destroyed by the above treat-

ment, and if the hold be closed for a like period afterwards, sufficient penetration will have taken place to ensure the disinfection of all those parts of the interior of the cargo in which these bacteria are likely to be present. Complete penetration can, in extreme cases, be secured by repeating the fumigation without opening the hatches. The bactericidal, insecticidal, and rat-destroying powers of this gas may be now said to be definitely established, and its limitations fairly well defined. I have, therefore, no doubt that any cargo may be disinfected by means of it, provided sufficient time be allowed."

In face of this and similar reports, the extermination of pests by means of gas will probably be seen at work on estates before long.

As for insects, Sandman points out that white ants (*Termes gestroi*) are chiefly injurious to Hevea as, by boring whole tunnels into the roots and trunk, they kill the trees. A remedy has, however, been found for this. By means of an air-pump, the gases, produced when sulphur and arsenic are burned (yielding sulphuric and arsenic acids), are pumped into the tunnels, causing death to the ants. The

tunnels may also be traced by means of a microphone, which intensifies the noise made by the ants and reproduces it so clearly, that the situation of the tunnels can be discovered, and by means of a boring machine, an entrance be made, through which the gas can be pumped.

Bordeaux mixture, which is composed of

Copper sulphate	4 lb.
Temper lime	4 lb.
Water	50 gal.

(This is generally known as the 4-4-50 formula).

is useful for many purposes ; a stock is therefore often kept for use as required. When this is done, however, care must be taken that the strength of the stock is kept constant, as evaporation of the water would tend to concentrate the stock preparation.

A large number of publications give particulars for making and testing, &c., Bordeaux mixture. The following is taken from the *West Indian Bulletin*, vol. x., No. 4, 1910, p. 368, where fuller particulars than I can give here are to be found. To make Bordeaux mixture the copper sulphate is dissolved in

25 gallons of water in a barrel or wooden tub. The most convenient method is to put the copper sulphate in a coarse sack and hang it from a stick across the top of the cask in such a way that it is just submerged in the water. The lime is slowly slacked in a wooden tub, and water added to make 25 gallons. The bluestone solution (copper sulphate) and the lime wash are mixed by being poured at the same time into a third cask capable of holding the entire 50 gallons of the mixture. The mixing can be done by two men, one pouring in the copper sulphate solution, and the other the lime wash by means of buckets. Copper sulphate and Bordeaux mixture should always be kept in wooden containers as far as possible, and the slaking of the lime should also be done in wooden vessels.

After mixing, it should always be tested for any excess of uncombined copper salts, which might be injurious to the plants to be treated. There are two recognized tests—the knife blade and ferrocyanide of potash. When the copper sulphate solution and the lime wash have been poured together and thoroughly stirred, the mixture may be tested by means

of a clean polished knife-blade placed therein and allowed to remain for a few minutes, or even for several hours. If the polished surface shows any reddish deposits of copper, more lime must be added; but if it comes out bright the mixture is safe to use. With the ferrocyanide test it is only necessary to add a drop to a small amount of the mixture, and if any reddish-brown colour is seen, it requires more lime.

Talking of canker, it is well for those who like myself, are interested in grafted cacao, to note that Mr. Joseph Jones, the Curator at the Botanic Gardens, Dominica (W.I.), warns his fellow-Islanders against the alligator cacao, *i.e.*, *Theobroma pentagona*, on account of its delicate character, but more especially owing to its tendency to become affected with canker of the stem.[1]

The disease, Mr. Jones reported at the time, was spreading very rapidly through the grafted alligator cacao. The disease attacks the scion, and rapidly rings the stem immediately above the point of union with the stock. Inoculation

[1] *West Indian Bulletin*, vol. x., No. 4, 1910, p. 340.

experiments conducted by Howard in Grenada, where ripe spores were introduced into wounds in cacao trees, showed that cankers, both *Nectria theobromæ* and *Calonectria flavida*, were parasitic in habit, for in each case distinct infection was produced.

In its early stages, *Nectria*, according to Stockdale, may be detected on account of the affected part presenting a peculiar dry, greyish-brown appearance. These greyish-brown areas do not dry as quickly as the unaffected portions of the bark after a shower of rain. Later on these affected areas split or crack, and allow a brownish-red, gummy fluid to ooze out. This is known as the "bleeding stage," and the disease is now well established. Canker appears to be more serious when it attacks the stem at about the level of the ground. In the rainy season the fructifications may be found. White pustules make their appearance through minute cracks in the diseased bark, and large numbers of conidia are produced, while subsequently the colonies of perithecia make their appearance.[1]

[1] The *West Indian Bulletin*, vol. ix., No. 2, contains a report of the West Indian Agricultural Conference

Die-back, determined by Massee as being *Diplodia cacaoicola*, at one time caused much trouble on the estates in Bahia, I think it was about 1904 or 1905, when *Tropical Life* was about starting, because the late Mr. Rowe, who first sent home the *Manihot dichotoma* seeds, sent me a book at the time descriptive of the disease, and with photos of the trees, showing how badly they were attacked. The trouble commences in the younger twigs, and spreads from them to the larger branches, causing the tree generally at the ends to appear "stag-headed," or as if stripped back by winter. The dividing line between dead and living wood shows the twigs to be black and quite dead, and then an intermediate, brownish-coloured zone is noticed between the dead and living tissues. Microscopic examination reveals fungal hyphæ in this transition zone, which are at first colourless and then brownish.

in 1908, with very full details of experiments carried on on cacao estates, especially to combat disease, and is well worth obtaining, if in stock, from the Imperial Department of Agriculture, Barbados, B.W.I., price 6d. "The Fungus Diseases of Cacao, and Sanitation of Cacao Orchards," by Mr. Stockdale, is worth many sixpences.

After wet weather small black pustules will be observed to break through the bark; from these, the spores of the fungus may be obtained.

Die-back, according to Howard, is a facultative parasite, able to live upon dead cacaowood, shells of cacao pods, and upon sugar-cane. It seems to be a wound parasite, and capable of seriously affecting sickly trees, hence the reason for keeping the estates well manured, and the soil supplied with adequate plant-food and stimulants for the trees. Thrips and die-back may be found together, as if the thrips make wounds through which the fungus can gain an entrance; this, however, has to be proved.

This disease does not readily attack trees in a vigorous condition of growth. Every effort should, therefore, be given to thorough cultivation, all diseased branches and twigs should be cut out and burned, and all wounds thus made should be followed by an application of coal-tar or some similar substance.

It has been demonstrated in St. Lucia, by the work on the experiment plot at La Perle estate, Soufrière, that the disease may be

defeated by high cultivation, manuring, and attention to careful pruning. The disease has practically been eradicated from this estate, and it is reported by Hudson that the yield of cacao has been increased from practically nothing to over 1,000 lb. of cured cacao per acre, within six years. This fungus is not very destructive to carefully cultivated, vigorous trees, so every effort should be made to improve the condition of all unhealthy trees.

Pen manures and mulchings should be applied, and all weeds should be carefully buried. All dead wood and twigs must be cut out of the plantation and burned. The cuts should be tarred.

It is also important that the husks or shells of all cacao pods should be buried with lime, for it has been shown that heaps of old pods lying unburied about a plantation serve as centres of infection for the spread of disease. It has been suggested that cacao shells may be treated with lime on the surface, but it would be preferable that they be buried, for experience has shown that such a procedure is the most sure and the most economical of all the various methods that have been experimented

with in checking the spread of the fungus that is responsible for this disease and for the "brown pod rot."

In his paper read before the (1908) West Indian Agricultural Conference, Mr. F. A. Stockdale, when discussing the advantages of spraying cacao, expressed the view: "That spraying should be adopted throughout cacao orchards to destroy fungus spores with a view to preventing infection, but experimental evidence as to the economy of such a practice for the spores of the fungi causing canker is yet to be forthcoming. Favourable results have been obtained in some orchards in temperate climates from spraying for canker of fruit trees, but no conclusive evidence has yet been obtained in "tropical countries."

In considering preventive measures, it must be borne in mind that the fungi associated with canker are regarded as wound parasites, and therefore one of the duties on the estate must involve careful attention to all wounds. Cuts made in pruning should be smooth and close to the stem or branch, and should be tarred over, and it may also be found possible that

those made when picking cacao can be similarly treated. A joint of bamboo, filled with tar, corked at the top end, and with a small spiket hole just above the lower node to allow tar to drain on the frayed lower end, has been found to be a convenient form by which tar may be carried when pruning operations are being carried on. It may be carried in the left hand, and after a branch or a sucker has been removed tar can immediately be rubbed on. This dispenses with the carrying of tins, does not allow of tar being put on to such an extent as to drain down the bark from the wound, and saves considerable time.

Canker is generally worse in plantations that are densely shaded, for the condition of moisture and of semi-darkness assists in the development of the fungi and in the dispersal of their spores. The reduction of dense shade in order to let in more sunlight is strongly to be recommended where disease is prevalent, for it has been found in Ceylon and in other places that this is a matter that should receive first attention. It is possible that the judicious thinning out of shade should receive attention on many West Indian plantations, but it must

be adopted cautiously, for it has been observed that the direct rays of the sun, in some dry localities, have the power of splitting the cacao bark and of causing wounds to which fungus spores may at a later date gain entrance.

Mr. Cradwick recommends the use of sulphate of iron wash, that is, sulphate of iron and lime, for the prevention of canker on cacao trees, and for generally improving the condition of the bark and removing lichen and moss. Many careful cacao growers can give evidence that this has been a most useful wash and does what it is stated it will do. On the other hand, we find that some report adversely on the treatment, and claim that the trees will not blossom for a long time afterwards. Now, may not this be due to the way in which the wash is applied, for if the wash is scrubbed on to the bark roughly it will rub off the blossom eyes? It should only be painted on or brushed on lightly, and if done like this, of the strength recommended, it will not retard blossoming nor harm the cacao trees, but will rather stimulate them.

In fighting diseases and pests, one has of course to pay serious attention to the matter of the cost. This book has not been prepared to

circulate among those who are merely engaged in determining the proper name of a disease, and then finding out the antidote. It is intended entirely for a class who, having found attacks breaking out on their estates, at once sit up and ask the question, If I spend £100 on curing the disease, will the increased profits gained through doing so amount to £101 and over? There is no doubt that this can be done, because, as has been seen in Surinam and elsewhere, if the diseases, whether on a cacao or rubber estate, are allowed to get the upper hand, there will be no profit at all either to the owner on whose estate it first breaks out, or, later on, to the neighbouring estates either.

It is on this account, if planters can only be made to see where their true interest lies, that prevention is both cheaper and better than cure. Adequate plant-food, a sufficiency, but not a surplus of fluid, light, air and water, and the spray machine always at hand when needed, will save large sums in the end, and do away with many anxious debates as to whether £100 spent will bring in £101 of profits. The *Agricultural News* of Barbados for July 23,

1910, had a very good article on the matter, which, at its cost of only one penny, is well worth obtaining, especially as it also contains full details of some spraying experiments carried on in Trinidad, which showed that spraying with Bordeaux mixture and lime sulphur wash gave as a result 189 lb. more good cacao, from 500 trees, than was obtainable from 500 unsprayed trees growing on the next plots, and under the same conditions of soil, drainage, shade, &c. Mr. J. B. Rorer, M.A., Mycologist to the Board of Agriculture in Trinidad, also maintains, and in fact shows, that spraying is beneficial in other ways. The canker in Trinidad due to the fungus *Phytophthora omnivora* causes black rot of the pods, and the reduction in the number of diseased pods due to spraying, together with the direct effect of spraying on the trunks of the trees, would probably tend to reduce the amount of canker on any plantation, where spraying is systematically carried on. It is claimed, and apparently the right to the claim is proved, that when the proper strength of Bordeaux mixture is used, the spraying reduces several minor diseases, such as thread blight, anthracnose of

the pods, &c., and keeps the trees free from moss: this latter is a great advantage. Another factor that must be taken into consideration is the cumulative effect of spraying, as a result of which the increase in yield would be progressively greater for several years, until a point was reached at which the trees were giving their maximum yield under the general conditions which obtain on the plantations. I agree with the *Agricultural News* when it adds: "These are factors of considerable importance."

"Many Hevea trees," we were warned as far back as 1903, by the Government Mycologist, F.M.S., in his annual report, "were lost through wound fungi which obtained an entrance where a branch was broken off, or a wound had been made in some other way. Most planters now recognize the danger of bare wounds and cover the places with tar, but the practice is unfortunately far from universal." The cacao trees in Trinidad, West Indies, contract diseases in exactly the same way, and it was agreed that in theory at least, even when a pod was cut off, it would be worth while to apply an antiseptic to the

tree at the time of cropping. Mr. Boussigniac, of Trinidad, designed a very clever contrivance which can be screwed on to the ordinary Whitehouse cacao pruner used in that Island. By means of this, a rag or sponge steeped in antiseptic fluid could be attached in such a way that, as the pruner passed up after making the cut, the rag or sponge, following close on to the cutting-edge, rubbed against the wound and applied the fluid like a lotion.

The trade, not unreasonably perhaps, do not greet these "patents" with an enthusiastic welcome, and so I fear Mr. Boussigniac's idea will lie dormant *pro tem.*, but I have his wooden model at my office, in case one day the planters, by demanding such a tool, will cause it to be taken up.

Cacao Beetle.

With regard to cacao beetles, the remedies to be employed are various. Mr. Rudolph Anstead, when in Grenada, W.I., recommended the following, among others: "First of all, in beetle-infested districts, a careful watch should be kept on the trees for boring grubs. These, as soon as seen, should be

destroyed. They may sometimes be killed by probing the tunnels with a stout wire, but, usually, the best plan is to cut them out, following up the tunnel until the grub is found. All the damaged bark and wood should then be carefully removed with a sharp knife, and the wound coated at once with an antiseptic dressing such as tar or resin oil, the same dressing that is used for pruning wounds. *This is most important.* In beetle-infested cacao all wounds on the cacao trees, whether made purposely by cutting out beetle grubs, or by pruning, or even removing suckers, or accidentally by the wind breaking branches, should be at once painted with an antiseptic dressing, or the beetles will find them out and deposit their eggs. A good dressing which is being used in some parts of Grenada, and is, I understand, in constant use by Mr. Malins Smith, at Diamond Estate, is a mixture of resin oil and tar in the proportion of 1 of tar to 4 of oil. Resin oil is recommended by many as an excellent dressing, the only objection to it being that, as it is colourless, it is difficult to see which wounds have been treated and which have not, and

unless care is taken some wounds are apt to be missed. The admixture of a little tar colours the oil and prevents this, and also the mixture sets better, the oil being rather thin and apt to run. Other men of long experience maintain that the only ones who benefit by the use of resin oil are the sellers; who is right can easily be proved, and the oil, meanwhile, does no harm to the trees.

"The next best method of prevention to be adopted is to kill the adult beetles, and so prevent them laying eggs. This can be done in several ways. The most effective is probably by collecting them by hand.

"The beetle is a night flier, and in the early morning may be found resting on the cacao trees, usually in the forks, and at this time they may be collected. Gangs of children can be usefully employed in this work. They go to each tree and shake it, when the beetles fall to the ground, and may be picked up and either immediately killed, or dropped into tins containing water and kerosine, in which they soon die. This method is the one adopted on most of the big estates where beetles are present, and it is a good method, provided

that there is co-operation." Everyone in a beetle-infested neighbourhood should have gangs at work collecting beetles, or otherwise they breed in one place to be caught in another, and there is no end to the work. In this matter, as well as in so many other cases of attacking disease, such as black blight, diplodia, thrips, &c., as I am constantly telling you, co-operation is needed and badly needed, in Grenada. What is a slow and difficult task for one individual becomes a comparatively easy one for the general community.

"Another method is to set baits to attract the beetles and collect them from these baits. The beetles are very fond of several other trees besides cacao, especially of the bread nut (*Artocarpus nucifera*) and if logs or branches of this tree are cut and laid about in the cacao fields, and regularly visited, many beetles can be collected on them. As soon as it is noticed that grubs are working in these logs, they should be taken up and burned, and fresh ones put out. The same thing can be done with prunings. When a field is being pruned, the wounds should be dressed

at once, and the prunings left on the ground for a week or two, till they wilt.[1] The beetles are attracted by these prunings and lay their eggs on them, and in a week or two they may be collected, full of grubs, and burned. It is not sufficient to bury them, unless it is done very deeply, as the beetles can work their way out of a considerable depth of loose soil. If baits are used it is most important to watch them and burn them as soon as they are full of grubs. If they are neglected at this stage a suitable breeding ground has been provided for the beetles, and the pest is increased instead of decreased.

"Beetles are attracted also by the heaps of broken cacao shells, too often I am sorry to say, found lying about in the cultivations. For many reasons, which I have often explained to planters, these shells should be buried, and here is an added reason, viz., that they attract the beetles to the fields."

In Surinam, according to Mr. H. A. Ballou,

---

[1] Others object to this, saying that it is better to destroy the beetles before the eggs are there to require being destroyed.

M.Sc., Entomologist to the Imperial Department of Agriculture, "it is the common practice to tie large pieces of bark of the silk cotton tree on to the trunks of the cacao trees to furnish a hiding place for the beetles.[1] They may be collected from these places during the day. It would seem likely that strips of burlap, or bagging, tied round the trunks, would have the same effect, and furnish convenient places for collecting the beetles."

In his lecture before the Egba Farmers' Association at the beginning of this year,[2] the Government entomologist gave the following instructions for preventing the cacao beetle and other pests from affecting the cacao trees:—

Describing the beetles first, he explained that "From each of these eggs (of the beetle, *Steirastoma depressum*), which are very small, there comes out a tiny crawling creature which at once commences to feed on the wood of the trees. As it feeds it of course grows larger, and is soon large enough to be seen by careful

[1] Mr. Stockdale reports that of late this has somewhat fallen into disuse.

[2] *African Mail*, April 8, 1910.

search ; the wound which it makes in the tree helps to make it conspicuous. You must try and look out for the beetles at this stage before they have had time to bore far into the tree ; they must, when found, be killed at once, and the wound must be dressed with tar to prevent termites, of which we speak later, from entering the tree by them. If you have not noticed the beetles in time and killed them they will soon bore a tunnel right into the tree, and you must at once try and get them out and kill them. The best way of doing this is to twist a piece of stout wire up the hole and endeavour to pierce and pull out the borer. If you cannot pull it out, make sure that you crush it in the hole and kill it. Sometimes they have to be cut out with a sharp knife. In any case, make sure of killing the larva, and then be very careful to dress the wound made, or to cover the hole made by the borer with tar, otherwise termites will get in at these places, and the trees will soon die.

"The next point to be attended to in order to get rid of these pests is the collection and destruction of the mature beetles before they have had time to lay their eggs. Attention

must be paid both to the destruction of the larvæ and the beetles, and if you really take pains over these two matters, there should, in a short time, be no more trouble experienced from them.[1] The mature beetles are night fliers, and they will probably be found resting on the trunks of the cacao trees in the early morning. Look for them at this time, and destroy all you can by dropping them into a tin of hot water[2] which you must carry with you. If you do not find them at this time keep a good look-out for them at other times and try and discover for yourselves what is the best time for catching them. It may not now be the right season for them; if this is the case, still be on the watch for them in order that you may catch them at the right season before they lay their eggs.

"Another plan which should be tried as well as the above, is to tie loosely round the

---

[1] If wind or forest belts are near, they also will need to be carefully examined.

[2] "Better still," says Mr. Hart, "to carry a covered jar, and when full to empty it, or add a teaspoonful of bisulphide of carbon, which will kill the beetles in two minutes."

trunk of each tree a piece of sacking about two feet from the ground; the piece of sacking should be about one foot wide. The beetles will collect under these for shelter during the heat of the day, and may be easily collected and killed by anyone inspecting them in the evening."

Mr. George F. Branch, Agricultural Instructor in Grenada, strongly urges the small planters in that island to keep this pest in check. To do so he recommends them to encourage the children to catch the beetles and dig out the grubs from the trees attacked. At the same time Mr. Branch, in common with other tropical agriculturists, complains that whilst some estates take every precaution to rid themselves of this and other pests, careless or indifferent neighbours who neglect their estates render the work done much less useful, for as fast as the careful man clears his land the careless one stocks them again with a fresh supply of beetles. The *Journal of the Society of Arts* for August 13, 1909, has, on pages 793-4, an important article by Mr. W. M. Malins Smith, of Grenada, on the cacao-beetle and remedial measures to rid estates of the nuisance.

GRAFTING CACAO.

MR. W. M. MALINS SMITH advocates seed selection rather than grafting and budding to improve the types. It may be that by seed selection one could both improve the yield and the type of the produce, but that would not enable the planter to blend the qualities of two distinct varieties, such as the cinnamon break and delicate flavour of the criollo bean with the more prolific yield and the stronger nature of the forastero. To blend these together it seems to me that one must resort to grafting and budding. Hart, on the other hand, maintains that this is impossible. Mr. Frank Evans, of the Trinidad Botanical Department, urges the importance of the improvement of cacao strains by seed selection, and says that cacao planters would do well to give the matter serious attention. When the desired type of bean is evolved, its special characteristics must be retained, and the only reliable way to do so is to propagate by grafting or budding.

Mr. Malins Smith is now, I believe, preparing a book on cacao cultivation, but towards the end of 1908 he favoured me with the following notes on the question of grafting *v.* seed selection for cacao. In his covering letter he wrote (September, 1908):—

"*Apropos* of grafting cacao, I am sorry to say that I do not agree with the advocates of this method of propagating cacao. I have written a short paper on the subject which was discussed at a meeting of our Agricultural Society, and although advocated strongly by some, the majority of our planters still agreed that, to use an American expression, 'we had no use for grafting cacao in Grenada.' We cannot extend our cacao estates much more than they are at present, as almost the whole of our available cacao lands are in cacao. What we want here now, and what we are trying to evolve, is a more intensive cultivation so as to increase our yield per acre as much as possible.

"In order to plant out a hundred-acre field of a specific type of cacao by grafting[1] from a

---

[1] Here I think my namesake is inclined to be wrong. It would surely take less time to evolve improved types

single tree, several generations of that tree would have been compassed before obtaining the thirty thousand (12 × 12 = 302 to the acre) to forty thousand plants required for that field. Further, with cacao the variation from propagation by seed is not so exaggerated as some would have us believe. The sample of cacao which I sent to you in May was gathered from a field which I planted, I may say, almost with my own hands, on my father's estate,[1] 'Nianganfoix,' in this island about twelve years ago. This field was planted with selected seed from half a dozen trees growing together and of a specially good type of cacao. The whole field has come out perfectly true to type, that is for all practical purposes. I believe that slight variations do not matter very much so long as careful selection is made when seed for planting is required.

"During the past few years, the question of

---

of cacao by means of grafting than by the process of seed selection he gives details of further on. On p. 270 he, himself, speaks of his system taking possibly fifteen to twenty years.

1 It is a very fine sample. Bold, plump, good colour, good break.

budding or grafting cacao has been brought prominently before the planters in the West Indies.

"Experiments are being carried on at several agricultural stations by the officers of the Imperial Department of Agriculture for the purpose of proving the advantages claimed for this method of propagation, the most important of which is uniformity of type; but as only the very best variety of cacao would be selected for grafting, the planter would also be able to produce a uniform type of his best cacao. If these experiments proved successful West Indian planters might also obtain some of the best varieties of foreign cacaos, which if kept pure would enable them by means of budding and grafting to be certain of supplying manufacturers regularly with different blends and types of high-class cacao. Then again the planters, by grafting from trees that have been proved to be the best for hardiness, prolificness and immunity from disease, would obtain larger crops at a lower cost. All these conditions and advantages blended in a uniform standard or type of cacao are as much to be desired by planters as by the manufacturers.

"A common practice with many planters who even claim to select their seed for planting is this. A field is planted with seed selected from a special tree or trees of the same variety. The following year when vacancies in that field are to be supplied, it may happen that the special seed trees have no pods on them at the time, so the planter selects seeds from other trees which may be an excellent variety, but entirely different from the first; and with such supplies he plants the vacancies in that field. The result is a great mixture of different varieties in the same field. The same practice is carried on when supplies from nurseries are used. The variety of kinds on the estates therefore is due entirely to the former slipshod methods in vogue among planters in the West Indies.

"Another great cause was owing to the fact that the majority of cacao was planted by the negro peasants in gardens leased or granted to them by the estates. To these people one variety of cacao or another was all the same thing, since it was cacao.

"We are, therefore, to-day confronted by the mixed varieties of the trees in our cacao fields,

and we desire to improve this condition as much as possible, first by planting uniform types in our new lands and next by gradually renovating our old fields with supplies of improved and uniform types.

"We are told that the sole method by which we may attain our end is that of budding or grafting; and the advantages to be gained, as described above, are placed before us. We are told that 'this practice of budding and grafting is always followed in Europe and America, as without it the maintenance or permanence of a fine kind would be a simple impossibility' (J. Hinchley Hart, *Tropical Life*, May, 1908).

"But there is one thing that we are not told by the advocates of grafting cacao, and that is whether the seed of the cacao would decrease in size from the practise of propagation by budding and grafting. But what has the writer to say about the several types of corn which are being grown in America; types produced by breeding and selection; distinct types which have been bred from the common varieties for specific qualities, such as larger percentages of protein, fat, or carbohydrates.

These varieties of corn have been bred into distinct types by hybridizing and seed selection, not by grafting, and have maintained their distinct characteristics notwithstanding that they are propagated solely by seed.

"I grant that it would take many years, perhaps fifteen or twenty, to produce distinct types of selected cacao fixed in their several required characteristics; but it seems to me that only by this method of breeding and seed selection lies the high road to success in the improvement of cacao, so as to improve not only the health and disease-resisting power of the tree, its vitality, its habit and form, the quality of its beans or seeds, but also its yield in both size and number of the seeds. It is for this last only that cacao is grown."

Pamphlet No. 61, of the Imperial Department of Agriculture for the West Indies, deals with the grafting of cacao. In it we are shown by Mr. Joseph Jones, Curator of the Dominica Botanic Station, how the operations are carried out, and the illustrations which are included clearly show how the work is done. Dr. Francis Watts, the Imperial Commissioner of Agriculture for the West Indies, in his preface

to the book, says that if the system of grafting can be carried on extensively, it will enable the planters to transfer from one tree to another any desirable quality or qualities possessed by the two kinds to be utilized, and thus enable one to carry forward faithfully from generation to generation many characters, such as prolific bearing, vigorous growth, resistance to disease, &c., that cannot be obtained from seedlings with certainty.

On the Gold Coast in 1905, twenty-four plants of *T. pentagona* were grafted on to *T. forastero* stocks, and took well. In Dominica, a number of shoots of alligator cacao (*Theobroma pentagona*) were grafted on to Forastero stocks, an experimental plot of sixty-two grafted plants in all being formed. Mr. Jones, in his paper, pointed out that the pentagona tree is very similar in habit of growth to the *T. cacao*. The pods are borne the same way on both trunk and branches, but their shells are thinner, and soft enough to yield under pressure of the thumb and finger, or if dropped to the ground from a height of 5 or 6 ft. will burst open.[1] The beans are

[1] *West Indian Bulletin*, vol. x., No. 4, p. 338.

large and when cut across show a large proportion of white in colour, but occasional pods show all-purple beans, and others again mixed white, pale purple, and dark purple. It is thought possible that the proportion of fat to be found in them will be higher than in any of the *T. cacao* varieties.

What goes against the use of the alligator, or *pentagona* cacao, however, will be the reports sent in by the manufacturers on the chocolate made from it: "In our opinion," said Messrs. Fry, "the cacao is not suitable for the English market, as the chocolate made from it has a peculiar taste and is different from that made from the usual cacaos." Messrs. Rowntree found the colour of the paste favourable, being of a good light-brown colour, but the flavour was rather thin and acrid. It is thought possible, however, to avoid such objections being raised, by increased fermentation or other means when preparing the beans for market. But the lack of strength, which Mr. Cadbury also noticed in drinking cacao made from *pentagona* beans, would not be remedied in this. This firm (Mr. Cadbury's), however, found that generally

speaking the flavour, if 'strange' is, taken as a whole, about as good as a great deal of the most expensive cacao of the Criollo type shipped from Venezuela or Ceylon. Here, therefore, is a report leading one to have a more favourable opinion of the beans from a manufacturing point of view. Of course this is of the beans from pure *pentagona*, and if grafted on to *forastero*, the objections as to acrid flavour, thinness, &c., might be remedied. Hinchley Hart, in describing the characteristics of the Criollo variety of *T. cacao*, tells you that this variety is not quite so vigorous as the darker red kinds, the *forastero* and the *calabacillo*, and though a fairly good bearer, does not yield so well as these darker kinds, but the quality of the beans is unequalled. For increasing the size of the beans the Nicaraguan Criollo can be used, as the beans are very large, though light in weight. Its flavour is good, and the beans require but little curing. Therefore, urges Mr. Hart, if propagated by grafting, Nicaraguan criollo should become a valuable acquisition to planters, as it is highly probable that if grafted on to the stronger stocks of *forastero* or *calabacillo*, which are heavier

18

yielders, the returns would be increased, and the colour and quality improved. It certainly, whilst improving the strain, would do away with the numberless mixtures of breaks and colours, and cures, that are the characteristics of Trinidad cacao. Some people, Hart urges, appear to think that grafting influences improvement by the union of the two kinds, and attempt to attach a sexual process to the operation. Of course, in such a case, they make a great mistake. Grafting is merely a means of perpetuating a particular kind in such a way as to keep it true for generations. If it were otherwise, how could the Ribston Pippin apple still remain the same after being continuously propagated after so many years? Cradwick, in Jamaica, maintains that grafting or budding, which is much simpler and easier, is the method of the future, but must be accompanied by "good cultivation" in every detail, or else it should not be attempted. "I do not know," he adds, "how many cacao buds I have 'put on' and never lost one of them, whilst the buds grow at a surprising rate. I cannot agree with your want of faith in the criollo tree as a 'bearer.' I gathered

102 ripe pods at a picking from a criollo tree, then 86 more a fortnight later, when I counted 130 large-sized pods still on the tree. This makes 318 pods in all, besides what had been gathered before I came, and the small ones to follow on."

Mr. Casse, of the well-known Bayeux Estate, Hayti, has kindly contributed the following notes on "Budding Cacao in Hayti:—

"The practical work connected with the cultivation of the cacao tree reminds one in many respects of that carried on in connection with northern fruit trees. In pruning one may, with some modifications, follow the rules applied to apple trees, whilst soil tillage, drainage, &c., is nothing else than ordinary orchard work. The propagation of cacao trees is, however, quite different, the cacao planter, at present, having to depend on seedlings as bearing trees, against the fruit grower, who uses the plants raised from seeds only as a stock on which the tree-produced plant—the graft—develops.

"The fact that the cacao tree is to be continually raised from seeds places the planter

at a great disadvantage; it results in endless and uncontrollable variations in respect to colour and quality of fruit, bearing, growth, and hardiness of habit. It makes the establishment of a cacao plantation an almost hazardous undertaking, because one cannot be certain of the quality of the plants put out. The low average yield recorded by cacao planters, varying in different countries from 1 to 5 lb. (the latter very rare), is due to the fact that a number of trees always fail to bear well, or when the bearing commences some of the trees may show lack of vitality and die back, whilst others standing next to them bear profusely and continually.

"The economic loss suffered by the planter through the variation to which the species is subject is enormous, because no intelligent selection can commence before the trees are five or six years old, which is rather late for replacing. If one obtains an average yield of 3 lb. per tree under careful cultivation, and would compare this average with the yield of a single good tree, several of which are generally to be found on every estate, and which may yield from 10 to 15 lb. annually, one will

Budded Cacao Trees, Plantation Bayeux, Hayti.
Budded, January, 1906; photographed, March, 1909; bore a few pods in 1908.

appreciate the advantage attainable through the selection of this bearing capacity and its application to all the other trees. Through grafting or budding this advantage can be obtained, and passed on to other trees.

"Grafting of cacao, either through approach or through budding, has now been practised experimentally for several years, but these experiments have chiefly been confined to botanical gardens, where the influence of field conditions could not be demonstrated. In the present lines we propose to throw some light on the subject from the point of view of the large cacao planter, whose trees are in the open estate.

"Grafting by approach has already been ably dealt with in the pages of your Journal, and we shall therefore pass it over with a few words, especially as it appears to be too complicated and too limited a way of propagation to become general. When this system is followed, a tree of well-known good quality is encouraged to develop many vertically growing shoots. A wooden stage is constructed around the tree, and on this are placed cacao seedlings in pots or bamboos. The vertical shoots

Budded Cacao Trees, Plantation Bayeux, Hayti.
Budded, January, 1906; photographed, March, 1909; bore a few pods in 1908.

on the mother tree are now approached and grafted to the seedlings. As above indicated the number of plants which can be obtained from one tree is very limited, and the work which follows, with attention to the young grafts in the pots on the stages, which is easily accomplished in a nursery, becomes too complicated to be practical under field conditions on an estate.

"The operation of budding cacao has been described several times, and first by Mr. T. J. Harris in a paper, "On the Budding of Cacao," published by the Jamaica Board of Agriculture in 1904. It is remarkable that a bud cut and inserted under the bark, as is the practice with fruit trees, will not take on the cacao tree, no matter how carefully the operation is performed. On the other hand, a bud with a square piece of bark, say 2 in. by ½ in. in size, will take readily when applied to the stem of a cacao tree in vigorous growth, where a piece of bark of similar size has been removed.

"The routine of the operation will in practice run as follows: The mother trees are selected, due attention in doing so being paid to (1) the quality of fruit; (2) bearing capacity

and healthiness of growth; this done, the development of gormandizers or suckers on such trees is encouraged. When the gormandizers are of convenient length—say 3 or 4 ft.—they are removed and the leaf blades cut off, the pericles being left; then the gormandizers are carried to the field where the budding has to be effected. The young plants to be grafted should have been planted in the usual way, and be $1\frac{1}{2}$ to 2 years old, with a diameter of stem of at least $\frac{1}{2}$ in.; they should be in vigorous growth. Care should be taken that the gormandizers are not left lying about for any length of time; each workman should only bring enough for half a day's work at a time. After the bud has been removed with a square piece of bark—an operation too easy and simple to need description—a piece of bark of similar size is removed from the stock, and the bud, after having been fitted, is attached with rafia. No grafting wax is needed, the buds take extremely readily, and after about three weeks the stock can be cut off or preferably broken off an inch or two above the bud. After this, the treatment is the usual one given to young cacao plants, only care should

be taken to remove wild growth as soon as it appears.

"Two years after budding, the new plant will bear a few pods, and on the whole the budded plant will bear earlier than those planted simultaneously and not budded. It will grow smaller and more compact, so that the plants intended to be budded can be and should be planted closer together than is generally the practice, 9 by 12 in. being a good distance, instead of 12 by 12 in., or even farther apart. Our experience in budding cacao is still not yet old enough to *prove* that the trees raised in this way will *always* bear more fruit than those not budded. It is, however, certain that if all the buds have been taken from heavily bearing trees, nearly all the trees resulting will be heavy bearers, because the bud is an example of vegetative propagation, and therefore transmits exactly the qualities of the mother plant. The vitality of the stock will, of course, influence the growth of the bud, and care should be taken only to operate on strong growing seedlings. In planning out cacao for the purpose of grafting, it is to be recommended to place two plants at each stake, with a little

distance between, and later to bud on the strongest.

"As will be understood from the above, the budding operation is an easy one, which can be taught to any class of labourer. The budded plants require but little extra attention, and are easily dealt with in the regular routine of the estate work. Considerable experiments must still be made, however, before one can decide on all the details as to how the operation can best be carried out, such as selection of stock, season for budding, height above ground at which to place the bud, &c.

"The photographs which accompany these lines (pp. 277 and 279) represent cacao trees budded in January, 1906. When photographed in March, 1909, they carried a fair share of pods. As can be seen, in 1908, they had borne a few pods. It was purple Trinidad forastero on Haitian calabacillo. The trees form parts of lines of similarly budded trees, and have received no extra attention.

"We have had a very bad winter here. A cyclone passed over our estates in November last, and we had severe floods during November and January."

THE PROPAGATION OF CACAO BY BUDDING OR GRAFTING.

By J. Hinchley Hart, F.L.S.[1]

Cacao has hitherto been grown almost entirely from seed, and the result of this method is seen on the estates of the present day in the innumerable varieties possessing interbred qualities of the original kinds. Variation from seed is now so well understood that it is evident other methods of propagation must be adopted if improvement is to be made and the quality of cacao raised.

Among the many seeding kinds on estates, there are to be found exceptionally good trees which possess a great vitality and produce beans of high quality, while on the other hand many are poor in quality. Attempts are made to reproduce the best kinds by seed, but the result, as a rule, is unfavourable to progress, from the fact that, owing to variation, few trees are

[1] This article appeared in *Tropical Life* of May, 1908, but the suggestions offered are still worthy of consideration by those who, like Mr. Evans, of the Trinidad Botanical Department, wish to establish a good strain of cacao trees.

obtained which could be classed as true representatives of their maternal parent. From a single pod of a yellow cacao, many trees will be produced which will bear red pods only, the form of the pod may vary in each of the seedlings in a most marked degree, and the quality of the produce shows similar variation. It may be admitted that a family likeness to the parent is generally to be noted; but this *is not sufficient* for purposes of real improvement.

It is to be noted that seedlings are only used in other countries as a means of obtaining, by selection, improved varieties; that is to say, selections are made from large numbers of seedlings of trees showing superior qualities, and these must be afterwards propagated solely by budding and grafting, to be maintained true to the selected type. This practice is always followed with fruit trees of all kinds in Europe and America, as without it the maintenance or permanence of a fine kind would be a simple impossibility.

We can easily understand, however, what a difficult thing it would be to carry out the operations of budding and grafting on a cacao estate which is in course of formation on lands

covered with virgin forest, without skilled hands trained to propagate by such methods. Now that such hands are available from the Government gardens, and even in some of the country districts, it would appear that there is nothing to prevent the European practices of budding and grafting being regularly adopted on cacao estates. There is nothing in the process which need frighten anyone, either on the score of expense or of time, and it is confidently expected that ere long the method of grafting will not only be taken up, but will be generally adopted. Under this method the proprietor can select from his fields certain trees which he knows to possess :—

(1) High quality and vigour.

(2) Good and regular bearing qualities.

(3) Good habit or form.

(4) A high quality bean which brings good prices.

With a few trees possessing these four qualities, a proprietor would be able to manufacture cacao samples having a regular appearance and standard quality impossible to obtain under present working conditions. The way to secure such a result is not difficult, neither is it expen-

sive, and although it may cost slightly more than the method of planting by seedlings, the results must, in a few years, fully compensate for the extra expenditure and time employed in adopting it. The advantages in a few years would be so apparent that, once seen and understood, no one would be able to deny their importance.

To those who are willing to give the method a trial, a few notes are added which will assist in carrying out the new departure.

(1) Go over the estate carefully and select a few trees, say a dozen, the size and vigour of which prove them to be suited to your soil. Number these consecutively and distinctly, and label each tree so that it can be confidently recognized again.

(2) When in season take six or eight ripe pods, and having removed the beans from them, place the latter in a net or muslin bag, numbering them by a wooden label notched with a knife with the number of the tree from which they were taken. Having secured samples of the beans place them in the "sweating box" or fermenting room with the main crop picked from other trees, and have

the beans fermented in the usual manner, and dried in the same way as the rest of the picking, keeping the selections distinctly apart in their several numbers. Keep the produce of each tree, when dried, by itself; and when the full number of selected trees have been collected from and treated, carefully examine each set of beans—I should advise this being done in the presence of an expert buyer of some large firm, who should cut a percentage of the beans and give the regular market value of the sample. The colour, "break," and nature of the skin or shell should be duly noted, as upon these points much depends. Having had them valued, reject at once all that are in any way inferior as unworthy of further notice, as it is clear that only the best, or the very best, should be selected.

This is highly important, as without quality in the bean it cannot be deemed first class. Proprietors should not be discouraged if they find inferior beans produced by some of the trees, for if they find *one out of ten*[1] trees which will make high-class produce they will

[1] Raisers in Europe consider themselves fortunate if they get 1 in 500.

be fortunate. Having found this one, they should at once start propagating it. This is most easily done by the method of grafting by approach. The method is taught at the Experiment Station, St. Clair, Trinidad. The planter should have well-grown seedlings twelve to fifteen months old, of some strong growing kind ready for the purpose, and to these he should attach grafts from his selected tree. As soon as ready, plant the young grafted trees in good soil and get them to grow freely. If six or more grafted plants are obtained at the start, the operator can take by the same method six more grafts from each young tree in a year's time, and will then have some forty-two trees in all. In three years he can take off probably 100 grafts, and by continuing the operation will have sufficient for his fields in regular sequence each year.

(3) Plant each new selected kind by itself, and proprietors will then have a set of trees all of one kind, each one producing cacao of exactly the same colour, size, character, and quality as its neighbour, and when the produce is ready, he will have a sample which will be certain to obtain the very highest market

price. Such produce will have a character of its own which may be individualized by giving it a distinguishing name. An estate planted on this principle would soon have its "Excelsior" cocoa, its *ne plus ultra*, its McEwen's prolific, &c., &c. By giving a name to individual varieties buyers would soon learn these names and the names would become standards of quality to guide the manufacturer in his blending rooms as well as on the market. Some may say that one soil will give a different quality of cocoa to another. This is an untenable proposition. The soil may affect the size of the bean and the vigour of the tree, but if the beans are all grown on trees obtained by grafting or budding from an original stock, the quality will not be affected in any noticeable degree; in fact the quality will be even and alike from year to year. It is so with the various pears and apples of certain well-known kinds. They come to us year after year of the same colour and flavour; and why? Because they are all grown from the same original stock. The planter who first adopts the process here suggested will be able practically to command his market, and those who grow

only mixed seedling kinds will certainly fail to secure so good a return as his more advanced brother; provided, of course, that the selection of the original stock has been made with proper care and on true scientific lines. The stock of a newly selected apple or pear is often placed on the market, and instances have been known where hundreds of pounds have been paid for the right to propagate and sell plants from such a stock. Why the same process should not be adopted with success in raising standard varieties of cacao the writer fails to see. The cacao plant readily yields to the practice of budding and grafting, and therefore there is no practical objection to the adoption of the method, and the advantages to be gained are so many and so important that, once started and its value recognized, it would most assuredly become the common practice on all first-class estates. Let Trinidad take the lead in due time, as there are important hints reaching us that the method is, or shortly will be, adopted by several new competitors in foreign countries. A parallel case may be quoted by referring to the orange and the mango. What exporter would now plant a

seedling orange, or a seedling mango, when he knows that he can secure selected and standard budded varieties which will bring him far better returns than unreliable seedlings?

As regards which kind can be used for the parent stem and which for the grafts, I find that the Nicaraguan Criollo, grown from material I brought from that country in 1893, is by far the best form of cacao, at any rate in Trinidad, for grafting on to another kind. For the parent stem I suggest that "Calabacillo" should be used.

CACAO IMPROVEMENT BY SELECTION.

By Mr. Frank Evans,

Of the Department of Agriculture, Trinidad, West Indies, at present attached to Hawaii Sugar Planters' Association Experiment Station.

The most promising work for the future in cacao cultivation is the improvement of existing and the raising of new varieties. So far this

work has received scant attention. All improvement is governed by the law of evolution, the theory of which is, that all known forms of life are the result of constant change through countless ages.

The earliest investigators of the evolution theory, recognized that continual use of any particular organ or set of organs tended to permanently increase their size, while continued disuse through successive generations weakened them until they finally disappeared. Darwin's researches, based on the theory that the reproduction of life is so much in excess of the food supply that only individuals or groups of individuals can exist whose special characters enable them to escape destruction in the battle for life, led him to the conclusion that plants and animals in their present-day forms are due to natural selections; in other words, they are the "survival of the fittest." Change and struggle in Nature still goes on; individual forms of life continue to vary, as they are influenced by the factors of inheritance and environment.

It is by carefully studying and judiciously taking advantage of the many variations which

occur, that the improved plant can best increase the strength, beauty, or crop-yielding capacity of any particular group of plants.

Plants may be improved by cross-breeding, by cultivation, by change of environment, and by selection. As an example of the first method, may be mentioned the work of the European orchid growers, who, by cross-breeding, have raised a class of plants unknown to the world fifty years ago.

The sugar-cane industry of the British West Indies has been saved from ruin by the raising of seedling canes. By selection and improved methods of cultivation the sugar content of the "beet" has been trebled within a hundred years. Numerous other examples could be cited.

The application of the law of improvement by selection and breeding, which has so wonderfully developed other members of the vegetable world, can be as advantageously applied to the cacao tree.

Broadly speaking, the chief qualities looked for in the cacao tree are immunity from disease, improved flavour, increased size and uniformity of bean, and productiveness. Weaklings

should be weeded out and only the trees strong in these essential characteristics allowed to live.

The first thing to do is to set a standard of general quality, including, as far as possible, all the desired characters of an ideal tree. The trees which over a series of years under good cultivation fail to conform to the standard should be destroyed.

The elimination of unproductive and poor quality trees is as important as the destruction of waste pods and diseased trees; the latter spread disease, and the former by cross-fertilization with, perhaps, superior types, transmit their undesirable qualities to future generations. "Like begets like," and good progeny cannot be expected from an inferior parentage.

Only the largest and heaviest seed from the best-developed pods of selected trees should be sown. The seed pods, in all cases, should be chosen from areas containing trees of one variety.

The improvement of cacao by selection or breeding must necessarily be slow work, requiring patience and persistence, but it is the only way to develop a race of trees capable of

permanently giving heavier yields, together with better quality beans. In the words of Luther Burbank: "Cultivation and care may help plants to do better work temporarily, but by breeding, plants may be brought into existence which will always do better work, in all places and for all time."

RUBBER.

RUBBER ON THE GOLD COAST.

WHATEVER the truth about the yield may be, there is no doubt that rubber of fine quality, equal to fine Ceará biscuits, and second only to fine Pará, can be made from the latex of *Funtumia elastica;* moreover, it would appear that the trees reach maturity, when favourably planted, almost as soon as the Pará variety.[1] The older the trees the better will be the quality and greater the quantity of rubber produced, as in the case of Pará; and it is somewhat reassuring to know that the trees of this species can be replaced in a comparatively short time from seed. Funtumia, we are told here, offers one advantage over Pará in that a larger yield of latex can be extracted in a single tapping, and for this reason it is perhaps better suited for native methods. It does not

[1] Extract from the Report of the Agricultural Department of the Gold Coast for 1908.

seem likely, however, that the natives will go in for rubber to any large extent, because, the same as with the oil-palm, the returns, in comparison to the labour involved, apparently cause the West African to strongly favour cacao against all other products.

Plots of Funtumia planted in 1907 have attained the following average heights in December, 1908 :—

Planted.		Width apart.	Average height.
May	1907	18 by 10 ft.	11·5 ft. (girth, 4·8 in.)
—	,,	8 ,, 8 ,,	7·8 ,,
September	..	10 ,, 10 ,,	6·5 ,,
October	..	6 ,, 6 ,,	5·8 ,,
November	,,	12 .. 12 ,,	4·3 ,,
October	1904	20 ,, 20 ,,	26·5 ,, (girth, 14·5 in.)
,,	,,	15 ,, 15 ,,	26·5 ,, (,, 13·0 ,,)

The *Ficus vogelii*, an indigenous rubber known locally as Memleku rubber, produces a rubber of poor quality, more after the nature of Balata. It contains a large percentage of resin, and though the yield is large, it seems hardly likely to be worth troubling much about, unless fine hard keeps at 5s. per lb., or over; otherwise the comparative value of the *vogelii* would be too low to pay for working it.

With Hevea, small plantations were formed at the Aburi and Tarkwa Agricultural Stations

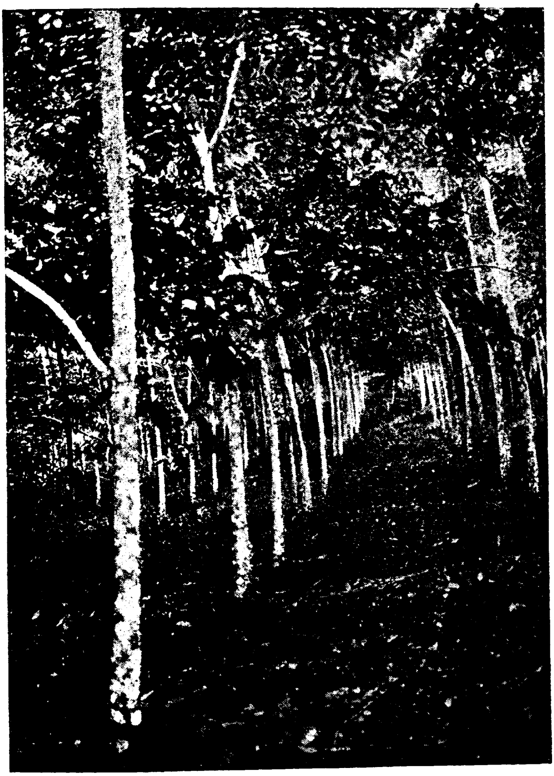
in 1900-01 and 1904 respectively. At Aburi, 154 trees were planted at 15 by 15 ft. in 1900-01, so are now nine to ten years old. Their average circumference at 3 ft. from the ground is 20½ in. The ground is described as rather dry and stony, and therefore not too suitable for Pará. Mr. Tudhope, the Director of Agriculture, therefore augurs that Pará rubber will grow and yield well on the Gold Coast, so long as not planted under jungle shade. The Director carried out some experiments in order to ascertain the quantity and quality of the rubber from Pará trees in the colony. One row of fifteen trees running through the plantation therefore was selected, and omitting one as being too small to tap, the others were tapped three times a week, on the half spiral system, from November 19 to December 31. The coagulation was done with the addition of a little acetic acid, and the rubber prepared in biscuit form; 2 lb. 8½ oz. of dry rubber were obtained, equal to 32½ lb. per acre. The rubber thus obtained was of good quality, and the results generally very satisfactory.

Fourteen trees were tapped, the girth of

them being as follows: 20½ in., 21 in., 25½ in., 18½ in., 16¾ in., 18 in., 18¼ in., 17¼ in., 10 in., 26½ in., 24 in., 20¾ in, 18¾ in., 19¾ in. The quantity of dry rubber obtained was 2 lb. 8½ oz.

Ceará (*Manihot glaziovii*) and Castilloa were also planted experimentally about Aburi, but the results are not promising. Liking a dry soil, the Ceará, it is thought, may do better in the northern territories, where experiments were to be carried out last year. The few trees planted, previous to December, 1908, were then growing well, and had attained (at the Tarkwa Station) an average height of 20·6 ft., and an average girth of 13·8 in., at 3 ft. from the ground. The trees seed freely, but so far they had not been tapped. The Castilloa neither seems to take to the soil nor the surroundings, and was vigorously attacked by a longicorn beetle that practically destroys it, attacking both root and stem.

We believe that the Pará trees planted in 1904 were tapped last year. To those who are still undecided as to the best distance apart at which to plant the trees, the following table may be of use. We soon hope to add to this



RUBBER GROWING ON THE GOLD COAST, WEST AFRICA.

the returns of the tapping experiments. Meanwhile it shows the rate of progress of the experimental plots at Tarkwa:—

Plot No.	Date of planting.	Distance trees planted apart in feet.	Average height December, 1908.	Average Girth at 3 ft. from the Ground. December, 1905.	December, 1906.	December, 1907.	December, 1908.
				in.	in.	in.	in.
I.	June, 1904	15 by 15	28 ft.	7	12	13	20
II.	,, ,,	12 ,, 12	25 ,,	6	10	12	16
II*a*.	July-Sept., 1904	12 ,, 12	27 ,,	4	10	—	19·29
III.	July, 1904	15 ,, 15	24 ,,	6	10	12	18·5
IV.	,, ,,	20 ,, 20	25 ,,	6	11	12	19
V.	,, ,,	30 ,, 30	27 ,,	4	9	10	16
VI.	,, ,,	40 ,, 40	27 ,,	4	9	10	16·5

At the Coomassie Agricultural Station some of the two-year-old Hevea are reported to have attained a height of 35 ft.,[1] and 6 in. in circumference at 3 ft. from the ground. The average height of the trees is returned as being 16 ft. Evidently the soil and surroundings suit the trees.

In the East, when a tree has attained a circumference of 18 in. to 20 in. at 3 ft. from the ground, it is considered tappable.

[1] Possibly this is a mistake.

This is not usually reached before the sixth year after planting, so an average of about 17 in. for every tree four and a half years old on the plantation at Tarkwa shows great promise for the species in the Gold Coast.

At Aburi the small plantation of 154 trees, planted at 15 by 15 ft. in 1900 and 1901, shows an average circumference of 20½ in. at 3 ft. from the ground, which is also very gratifying, as the soil here is drier and more stony and not therefore what is usually considered quite suitable for Pará rubber.

A small experiment was conducted by the Director at the Gold Coast in the latter part of 1908, with a view to determining the quantity and quality of rubber these trees are likely to yield. One row, as already stated, containing fifteen trees, was selected; and apart from the one which was too small to tap, the results, as representing the produce of the plantation, have been calculated on the total. They were tapped on the half spiral system and three times a week, the period extending from November 19 to December 31. The latex was coagulated with the addition of a little acetic acid and the rubber prepared in biscuit

form; 2 lb. $8\frac{1}{2}$ oz. of dry rubber were obtained, this being equivalent to $32\frac{1}{2}$ lb. per acre. Assuming that the trees are given a rest of three months every year, this works out at 206 lb. per acre per annum. The rubber is of good quality, and the result, considering the age of the trees, the nature of the soil on which they are grown, and the season of tapping, which was just previous to the wintering of the trees, may be considered very satisfactory.

It is evident, therefore, that Pará rubber will grow and yield well on the Gold Coast and, as the trees are now seeding freely, I anticipate a somewhat extensive multiplication within the next few years. The natives who have already planted it seem very pleased with its rate of growth, and are asking for more plants. As a native cultivation it should be very profitable, for it can be carried on in conjunction with cacao, amongst which it may be either planted as shade or set in belts round the plantation; but it is not likely to succeed well if planted under jungle shade.

The rubber at present exported from the Colony is the product of several latices, the most important of which is that of *Funtumia*

elastica. The jungle vine, *Landolphia owariensis,* also furnishes a good deal of ball rubber. The quality of most varieties of Gold Coast rubber is poor, owing to the sticky, resinous, unattractive mass which it presents. This is mainly due to two causes: (1) The native ignorance of improved methods of preparation; and (2) their habit of collecting and mixing every latex having a white milky appearance, in the belief that they profit by having for sale a greater quantity of so-called rubber. Much attention has been drawn to this product of late and to the wasteful system of tapping which has been going on. The Agricultural Department has, however, always done much good work in demonstrating various improved methods for improving the preparation of the rubber and in afforestation, several million plants and seeds having been raised and distributed from the Agricultural Stations for planting in the forest areas. This is, in my opinion, essentially the work of an Agricultural Department, when, as on the Gold Coast, the planters need supervision and educating up to follow improved modern methods of production and preparation of their crops. The system of

tapping practised by the uninstructed natives is very wasteful, and the trees, where they have not been killed, have been very much disfigured by excretionary growths due to injury to the cambium, which renders a second, or repeated, tapping in subsequent years, well-nigh impossible. Mr. Tudhope, Mr. Evans, and the staff under them, deserve great credit for the work they are doing on the Coast among the native planters. If other centres do as well proportionately elsewhere among educated "whites," I do not think that we shall hear quite so much about the spread of pests and diseases in future.

The *Straits Bulletin*, some little time back, when discussing the planting rubber trees, pointed out that it has been the custom amongst tree planters in England to plant fruit trees in a somewhat elaborate way. A large wide hole, not deep, was dug, and the roots carefully spread out and arranged near the surface. The soil was filled in with many precautions, small quantities of fine soil worked in between the fine roots, hollow places between the stouter roots filled in, and the rest of the soil filled in and trodden down. Experiments

made by Mr. Pickering on the Woburn Experimental Fruit Farm, owned by the Duke of Bedford, show that this careful process is all wrong. The right way to plant a tree is to make a small hole, double up the roots anyhow, stick the tree in, and having thrown in the soil ram it down as hard as if one were fixing a gate post. The experiments showed 59 per cent. of the sets in favour of ramming, 27 per cent. showed no difference, and only 14 per cent. were against ramming. Examination of the trees showed that ramming led to a copious development of fibrous roots, and direct experiments proved that the fibrous roots produced in the nursery before lifting, played no important part as roots during the life of the tree. The important thing is to induce fresh root formation, and ramming induced this more rapidly than the orthodox method. The experiment would be worth trying with rubber and other trees, though I do not believe the idea generally meets with approval.

Mr. Cradwick, Jamaica, also seems to favour experiments along these lines, as he finds trees are often lost in Jamaica on account of slack planting, but reminds us that the soil at

Woburn would be well cultivated, which is seldom the case on estates in the Tropics, especially when first laid out.

Coming to India, Mr. R. L. Proudlock, as Curator of the Nilgiris Botanic Gardens, summarizes as follows, in his report for 1909, on rubber prospects in that part of the world: The chief drawback to the successful growth of rubber in the Bombay Presidency is said to be the long annual drought that is experienced. The best district for rubber is Kanara. In the fine evergreen forest region along the foot of the Ghats from near Bhatkal to Kadra, where the climate is hot and moist for a good part of the year, the conditions are, upon the whole, favourable for the successful growth of rubber, especially for Ceará and for Pará. Next comes Thana, where the climate is also hot and moist. Here, although the conditions are not so promising as Kanara, they are not altogether unfavourable. Kadna, situated within the Kanara district, is the best centre for the establishment of rubber estates on a large scale.

Crossing over to Nyasaland, Mr. Stewart McCall, Director of Agriculture, in his annual report for the year ending March 31, 1910,

says that it has been conclusively proved that the rainfall of the Shiré Highlands is unsuitable for Pará, and the only district that would suit this variety is West Nyasa, where the African Lakes Corporation have fully 600 acres doing exceedingly well. The rubber of Nyasaland, as stated elsewhere, is Ceará, with which some 4,403 acres are planted. Unfortunately, in the mistaken idea that rubber will grow anywhere, a large proportion has been planted on exhausted coffee lands, and so cannot be expected to do so well as some of the others. The most promising Ceará estate is situated near Blantyre, and from experimental tappings Mr. McCall is of opinion that around Zomba 3 oz. dry rubber (Ceará) per tree will be a good average yield (per annum) for trees over four years old. It must be remembered that for six months in the year there is no rain, and that tapping is only practicable during dry spells in the rainy season, and for one or two months after the rains have ceased. A marked difference in the flow of latex from cultivated and uncultivated trees was also noticed, and thorough cultivation in the fourth year is absolutely necessary to obtain good results. " It is

a general practice in Nyasaland," adds Mr. McCall, to catch crop rubber with cotton for the first two years, and several estates have found the profits from the cotton pay for the first three years' cultivation. This is a good practice, and much preferable to having rubber covered with weeds and grass; the cultivation given to the cotton more than compensates for the small amount of plant food removed."

I have, of course, similar notes from the other centres, but have had to cut them out. We will now come to the matter of tapping rubber generally, and then treat with Ceará specially.

Unfortunately I have not the space or time here to go exhaustively into the matter of tapping Hevea. Were I to do so, however, I could fill a book almost as large as this one, and even then come to no settled conclusion. I would recommend everyone interested in the matter, however, to secure a copy of Bulletin No. 10, issued by the Department of Agriculture, F.M.S., entitled, "A Lecture on the Pará Rubber Tree," by W. J. Gallagher, M.A., Director of Agriculture. Since this was written Mr. Gallagher

has, I regret to say, resigned his position as Director, but in this bulletin will be found everything necessary for a preliminary study on the subject of tapping Pará trees. Diagrams are freely introduced to illustrate the author's description of how the tree is built up, and the latex-bearing layer and outer bark are formed and effected by the cambial layer, &c. Full particulars, also illustrated, are given of the various methods of tappings, and their merits and disadvantages discussed. Mr. Gallagher, by the way, unlike Mr. Carruthers, is dead against prickers being used. "They form 'stone' cells," he tells you, "which take up the space of latex-bearing cells, and are a distinct loss."

TAPPING RUBBER.

I HAVE always maintained that owing to the more fleshy nature of the Castilloa bark, much more care and greater precautions are necessary when tapping this tree, especially in centres where pests are plentiful, than when tapping Hevea, although even then one cannot be too particular. Carruthers' experience with Castilloa in the West Indies confirms this, for he finds[1] that whilst with Hevea the use of the knife causes little or no gaping of the bark, with Castilloa the character of the tissues makes it difficult to cut clean and thin, and there is always a widening of the wound, which takes a long time to heal, and is the potential harbourer of insects, fungi and other undesirable camp followers of an estate. Mr. Stockdale also says that this had been his difficulty with Castilloa. So far, the best results he finds have been made with chisel

[1] *Trinidad Bulletin*, 1910.

incisions, but further improvements in tapping Castilloa must be looked for. Mr. Cradwick, in Jamaica, found the No. 2 Bowman-Northway knife satisfactory for Castilloa.[1] Whether satisfactory results can be achieved by Mr. Carruthers' suggested method of pricking Castilloa trees to obtain the maximum amount of latex remains to be seen, but I very much doubt it. Pricking is not too satisfactory with Ceará rubber, and with Castilloa I should have thought that the drawbacks would have been even greater. I mention the matter, however, to show that care and attention are necessary, when tapping Castilloa, if fungi and pests are to be kept away, especially in such a pest-ridden centre as Trinidad, West Indies.

In face of what the late Mr. Carruthers wrote from Trinidad on tapping Castilloa trees by means of pricking implements rather than by incisions, it is interesting to note that in 1908, writing from Kuala Lumpur, he suggested that :—

"There are 900 trees over nine years

---

[1] See *Tropical Life*, November, 1909, footnote on p. 178.

VIEW AT THE (1906) CEYLON RUBBER EXHIBITION.

old, on which a series of experiments will be made and all data recorded. Many problems of great economic importance await solution. The climate of Malaya differs so greatly from that of Ceylon and other rubber-growing countries that the results of experiments carried on there cannot with safety be used as giving reliable information for treatment of trees in this country.

"The whole question of tapping requires careful investigation. The results given by the thin paring of cuts at an angle to the axis of the tree are so good that planters are apt to consider the matter solved, *but it is not improbable that punctures instead of cuts may yet be found to give as good or better yields and involve less skilled labour.* All the 'prickers' which have up to the present been exploited are instruments, not for making a puncture, but a short deep cut, and consequently damaging relatively more cells of the tree than a cylindrical or sharply conical pricker. There is a large field for ingenuity and careful experiment; and the next few years should produce an instrument which will be a marked improvement on the present weapons.

"Excellent work with regular shavings, as thin even as 20 to 25 to the inch, has been done with the gouge, the farrier's knife, and with more modern specially adapted tapping knives.

"It is important to make certain of the periods which should be allowed to elapse between tappings, in order to get maximum yields. After having collected figures of yields on a large number of estates it is difficult to lay down an absolute rule as to the procedure which experience shows to be the best.

"Carefully kept data on some estates show that after a period of alternate days' tapping, extending over some three months, the amount of latex per tree decreases to an amount which is of less value than the cost of tapping, but after a rest of two months the tree again, on the fourth or fifth tapping, yields to the maximum, which after some forty tappings begins to rapidly decrease.

"The reverse of these observations is to be found on other estates, where accurate figures of yields show that after continuous tapping for some two or three years, the amount obtained varies only slightly, never steadily decreasing. The variation is caused by

By courtesy of Messrs. David Bridge and Co., Ltd.

SCIENTIFIC TAPPING IN BRAZIL.

Dr. Huber, Director of the Museu Goëldi, Pará, using the "Huber" knife on *Hevea braziliensis*.

climatic conditions, short periods of little or no rainfall reducing the yield, and periods of excessive rainfall producing somewhat the same result. This is due to the relatively less active functioning of the roots owing to drought or excess of water.

"Many planters believe in stopping when the trees are leafless, a period of some three weeks each year. The experiments which have been continuously carried on for some eighteen months by this department on 17-year-old trees at Krian show a slight decrease of yield during the leafless period.

"The notion is also prevalent that tapping should be discontinued during the fruit-bearing period. The figures obtained at Krian show a decrease during the time the trees were in fruit, but no sufficient decrease to seriously increase the cost of tapping. The figures relating to these tapping experiments will be published in the *Agricultural Bulletin*.

"Careful records have been kept of the weight and bulk of latex each day from each tree, and the ensuing weight of dry rubber.

"The question of how far it is advisable to refrain from tapping rubber trees after a period

By courtesy of Messrs. David Bridge and Co., Ltd.

SCIENTIFIC TAPPING IN BRAZIL.

Dr. Huber's task completed. Note the evenness of the cuts. A good specimen of the Half-herringbone system with *Hevea*.

of tapping, is one upon which planting opinion differs very greatly. On some estates, after a period of some weeks or months of tapping, a period of about equal length is allowed to elapse without tapping. On others, and the majority of places, tapping is continued without cessation, in some cases trees having, without any reduction of yield, been tapped for three and a half to four years every other day. On the question of daily or alternate days' tapping planters are also divided, and experience of yields points somewhat to the advantage of the latter practice.

"There is no physiological reason why the tapping should cease during the leafless or fruit-bearing period; the cutting of the small portions of the bark which tapping implies, being in the case of a tree of 20 in. or more in girth, so slight an injury as to be negligible.

"The best and simplest criterion for deciding how long to continue tapping is found in keeping a record of the amount of latex from each of 1,000 trees or from a field. If you find these figures show no serious and continuous decline there is no reason to stop tapping. On the other hand, when, after a series of tappings,

say forty or fifty, the amount of latex obtained decreases in a marked manner and this decrease is constant, the yields being less and less, then it is advisable to stop for a period of a month at least, and not to begin again until, by an experimental tapping, it is found that the flow is again large.

"On one estate the tapping after a number of cuts was habitually stopped when the yield had attained the maximum, and, after some weeks tapping, again produced less yield, which increased till the arbitrary time of ceasing. This method, which is adopted to a great extent from fear of using too much bark, is most profitable, as it leads to stopping as soon as the best yields have been obtained.

"It is naturally wise to so arrange tapping operations that it will not be necessary to re-tap renewed bark for some considerable period, but we do not yet know by experiment in the Malay States what length of time is necessary for a healthy tree, carefully tapped, to produce new bark containing a large number of well-filled latex vessels. The time of four years has been arbitrarily fixed by some planters and their tapping schemes are

arranged in relation to that period. That four years, three years, or two years are necessary for the formation of bark suitable for tapping cannot yet be definitely stated, but it is highly probable from isolated cases, where such experiments have been made, that four years is unnecessarily long.

"Experimental work and observations on tapping and yield of rubber made in Ceylon are unfortunately of little value for Malaya. The climate of Ceylon rubber districts, with its periods of dry weather, is not comparable with the conditions in Malaya, where rubber trees are in active growth of root, leaf and other tissues practically every day of the year, and where, even when they are leafless, the growth of trees is not entirely stopped.

"On one estate in Perak the yield of dry rubber per acre was 800 lb., a little less than 4 lb. per tree, even though the trees were crowded together 220 to the acre; this rubber was sold at an average price of some 4s. per lb., thus realizing about £160 gross profit per acre, of which more than 50 per cent. must have been net profit."

"If animals can be clipped by machinery, if

such an extremely delicate operation as stopping teeth can be performed by means of a machine worked by the foot, or other means, it is to be hoped," writes one of the best of our agricultural instructors, "that the makers of tapping tools will, before long, place upon the market some method whereby the latex can be extracted by machinery, as at present the work is tremendous, especially where labour is dear. A rotary tapper at present seems most likely to solve the difficulty. The idea is, of course, nothing new, and every one, undoubtedly, devoutly hopes that some such machine will appear."

Coming to the report published by the late Mr. J. B. Carruthers in the *Trinidad Bulletin*, last April,[1] he tells us that the methods of tapping Hevea which obtain in Malaya and Ceylon require the careful shaving of the cuts on each tree tapped some 120 to 180 times a

[1] "Rubber Cultivation in Trinidad and Tobago," by J. B. Carruthers. Illustrated (one of the illustrations is reproduced on p. 376). *Bulletin of the Department of Agriculture*, vol. ix., No. 64. Price 6d. Contains full details of rubber cultivation, and much valuable information *re* cacao and coco-nut diseases.

year. Both with tapping and weeding, however, the systems employed in the East are not so suitable for the West, on account of the higher cost of labour, as well as for other reasons.

"Since my arrival in the West Indies," he afterwards reported, "I have been making many tentative experiments and observations as to tapping Castilloa, and am of opinion that the methods which have been used for the extraction of the latex up to the present are unsuited to the structure of the tissue of Castilloa, and the arrangement of its latex vessels. The use of the knife in Hevea causes little or no gaping of the wound, and the bark tissues can be cut smoothly and very thin. In Castilloa the fibrous character of the tissues make it difficult to cut clean or thin, and there is always a widening of the wound, which takes a long time to heal and is the potential harbourer of insects, fungi, and other undesirables. For these reasons I am inclined to believe that if the latex can be extracted with the minimum of wound to the tree, and at the same time by a process that can be done quickly, and is therefore labour-saving, a great

advance will be made in the methods of tapping Castilloa."

Mr. Carruthers then describes the experiments he carried out to ascertain whether the Castilloa latex could be extracted by simply using sharp-pointed tools of various dimensions, but all of which could penetrate right down to the old wood with as small a puncture as possible.[1] He claimed that the first experiments gave excellent results per square inch of bark tapped. Importing other tools, he made a fresh series of experiments, particulars of which, together with his final conclusions, were to have been published, when his illness, contracted in Tobago, cut short his work.

It seems probable, however, that, even supposing this pricking process gave more satisfactory results than any other method, the question of cleanliness would always discourage its adoption. Not only must the latex remain on, or run down the bark, but water was to be sprayed on to the trees to encourage

[1] My experience of Castilloa tapping is that, unless you make a wide cut no latex comes out worth mentioning. These wide cuts are, however, a distinct danger to the trees.

the latex to flow, and prevent the holes being clogged with coagulated rubber. "My experience on this point has been, we are told, that while the flow from punctures properly made, without spraying or watering, lasted some fifteen to twenty-five minutes, if coagulation is prevented by applying water, the flow will continue for fifty to seventy-five minutes, and will result in some 30 to 40 per cent. more latex." Even if the trunks were scrubbed first, the latex under such conditions must get a little dirty, and it goes without saying that the trees, taking the Castilloa estates as a whole, will never get scrubbed, but that all the dirt, scraps of bark, &c., will be washed down with the water, &c., into the receptacles below. At the same time, planters should study Mr. Carruther's report, as he certainly was the third, and I would say second best rubber expert that we had, Mr. Ridley, at Singapore, being first, and Mr. Carruthers was certainly right in saying that the present methods of tapping Castilloa was conducive of trouble later on.

The Island (Pará) Rubber Estate, when floated in July, 1910, claimed that the cost

of producing their rubber, including drying, management charges, and freight to London, including export duty, was under 2s. 6d. per lb. About the same time the cost of labour in Brazil had an upward tendency, for Mr. Talbot, as Chairman of the Dumont Coffee Company, told the shareholders, "we were obliged to raise the rate of pay for weeding to 10 milreis per 1,000 trees, because it was impossible to retain our labour force at the lower rate, as all of our neighbours were paying more, or allowing their colonists to plant maize in the coffee."

In French Indo-China ten Pará trees, planted in 1898, were tapped every day for a year in 1908, and gave 14·497 kilos, or just under 2½ lb. each of rubber, which when well, but not absolutely dried, worked out at 1·160 kilos per tree of ten years old. The soil on which these trees grew is described as being sandy and poor in fertilizing elements.[1] Compare this with the Cicely estate, whose average yield is returned as being from 1·32 lb. up to 6 lb. per tree as different batches of trees, varying from 7,000 to 9,000 in number, were tapped.

---

[1] *Straits Bulletin*, quoting Bulletin of the Saigon Experimental Station,

On the question of pricking rubber trees for latex, Mr. Ridley writes in the *Straits Bulletin*, January, 1910, as follows :—

"A note on a new process of obtaining latex from a tree, by pricking instead of cutting, appears in the *Times* of Malaya, November 27, 1909, and is given below. Attempts to obtain latex in this manner are by no means new. The idea was that the tree would be less injured than by cutting it. Experiments in this direction were made in the Botanical Gardens in Singapore over ten years ago, but the amount of latex obtained was too small, unless the tree was injured, An ingenious local inventor, without having ever seen a Pará rubber tree, came to the Gardens with an invention consisting of a plate of kerosene tin so perforated that small portions of the tin projected like thorns from the back; at the basal point, the plate was triangular, was fitted like a cup, so that the latex would flow into it. This plate was to be hammered against the tree so that the teeth projected into the trunk, and the latex flowing through the holes ran into the cup. On being applied to the tree, the amount of latex produced was not

sufficient to enter the cup, and it ceased flowing almost immediately. Further it was found that the plate which fitted one part of the tree would not fit another, and so that one had to be made for each part of each tree and the ingenious idea had to be abandoned."

Regarding Funtumia tapping, the *Journal d'Agriculture Tropicale*, the *Tropenpflanzer*, and other papers have now and again devoted space to discussing tapping methods for Funtumia, and show that although other forms have been advocated, if not adopted, long vertical cuts down the trunk of the tree seem to be the most favoured. I have not space to go fully into the matter here, but the *Journal d'Agriculture Tropicale*, No. 80, March, 1908, p. 43, and No. 97, July, 1909, p, 198, gives some useful information on this method. From all I heard at the (1908) Rubber Exhibition, and from conversations I have had, and articles I have read since, I am prejudiced in favour of the long vertical cuts straight down the bark, and would not try the herring-bone system, unless the other one proved unsuccessful. Dr. Schulte im Hof, in the German Colonies, even used a gouge on a bamboo, like a cacao pruner, and the *Journal d'Agri-*

culture Tropicale in their July, 1909, issue shows such a tool in use. I hear very conflicting accounts of the yields of *Funtumia*, and some of the leading rubber men maintain that it pays in West Africa in some centres, at least, to cut out the indigenous Funtumia trees, and plant Hevea. As the men are Scotchmen I take it that they know what they are about, and are right, at any rate in connection with their particular properties. There is no doubt that properly prepared Funtumia rubber is an excellent raw material, but that is no good to the planter if he has little or no latex to make up. De Valda, in *Tropical Life*, August, 1908, also claims that spiral and semi-spiral tapping have proved unsatisfactory with Funtumia. One vertical groove produces, he claims, more latex than the same length of diagonal grooves distributed over a wide surface; this points to there being horizontal or secondary tubes in Funtumia, connecting the vertical or primary ones, and this is clearly proved by the microscope. De Valda recommends a knife of the gouge or farrier's knife character, similar evidently to the one used by Dr. im Hof, and states that a series of vertical grooves made at intervals

say of two months would, if cut 4 in. apart, completely tap one tree in the course of a year without inflicting the damage to the trees that the spiral or herring-bone systems undoubtedly would do.

Evidently it has been claimed that the Funtumia, the same as the Castilloa, will not yield satisfactorily out of the forest, for my friend Mr. A. E. Casse, of the well-known "Plantation Bayeux," Hayti, says: "As regards *Funtumia elastica*, I do not share the opinion that this tree is valueless in cultivation. It is a forest tree, and so naturally requires forest conditions. Under forest conditions Funtumia is a rapid grower, and not exposed to insect attacks as much as Castilloa.[1] It develops plenty of latex, which flows readily, but whether it will stand tapping we cannot yet say."[2]

To those trying to solve the difficult question as to which method gives the most satis-

---

[1] I have heard that in Java, Sumatra, and Ceylon, it suffers from grubs.—H. H. S.

[2] As stated elsewhere, I hear in Africa, the home of Funtumia, that the trees are actually being cut down, and Hevea planted instead, as the indigenous rubber yields so very unsatisfactorily. But are these *F. elastica?*

factory results when tapping Funtumia, the following results taken from the 1909 report of the Aburi (West Coast Africa) Experiment station may prove of use. The yields obtained, however, are not very satisfactory, unless you can get 1·34 oz. every time you tap according to the native method. I take it that, by leaving 18 in. between the vertical cuts, a good number of tappings could be done in the twelve months. At the best, however, the yield is poor compared to Hevea in the East. It will be interesting to see what yield the Hevea trees will give later on on the West Coast, or whether fertilizers can be judiciously applied to increase the Funtumia yields.

At the Aburi station, the plantation of Funtumia trees was started in 1902. At the end of 1909 the gardens contained some 12,800 trees, with an average girth of 13 in. Tapping experiments were carried out during the latter part of 1909 on seventy-five of these trees, divided up into five blocks of fifteen trees each.

In the first four blocks, the trees were tapped seven times, at intervals of ten days, up to a height of 6 ft. Block V., where the native

system was used, was only tapped once, but in that case the cuts extended 15 ft. up the trunks. The five blocks were tapped by the following methods, viz.:—

Block I. Herring-bone System.

Block II. Vertical System.

Block III. Half Herring-bone System.

Block IV. Full Herring-bone System.

Block V. Native System.

Block I. (Herring-bone System).—Fifteen trees—average girth, 3 ft. from the ground, 18½ in. At first, side cuts were made at intervals of 12 in., on each side of a vertical cut. Subsequently cuts were made between these, so that about 1½ in. of bark were left intact between each tapping. Total weight of dry rubber obtained from seven tappings = 12·10 oz., or average yield per tree of ·807 oz.

Block II. (Vertical System). — Vertical parallel cuts made at intervals of 1½ in., average girth of trees 19 in. Total weight of dry rubber from seven tappings = 14·34 oz., or an average of ·956 oz. per tree.

Block III. (Half Herring-bone System).—Half of each tree was tapped. Vertical cut first made, then side cuts at intervals of 9 in. Subsequent cuts 1 in. below the previous cut.

Average girth of the trees, 18¼ in. Total weight of rubber obtained from seven tappings = 9·17 oz., or an average of ·611 oz. per tree.

Block IV. (Full Herring-bone System).—The whole circumference of the tree was tapped. The vertical cut made first, then side cuts at intervals of 9 in. on both sides of the vertical cut, subsequent tappings at intervals of 1 in. below each previous tapping. This block gave the best result, although I consider that even here, the yield cannot be considered as satisfactory from a commercial point of view. Total yield of rubber from seven tappings, 20·45 oz., or an average of 1·36 oz. per tree.

Block V. (Native System).—This experiment was made in order to compare the native methods, viz., to tap high up in the tree, with those already described. Fifteen trees of an average girth of 18½ in. were therefore tapped *once*, to a height of 15 ft., on the full herring-bone system, and the yield amounted to 1·34 oz. per tree, or only ·02 oz. less than the yield obtained from Block IV., and as the working expenses incurred by this, the native method, are considerably less, it must be considered to give the best results.

RUBBER DISEASES.

As was reported in the 1908 report of the Director of Agriculture of the Federated Malay States.

"The climate of Malaya is exceptionally favourable for rapid and healthy plant growth; but these conditions of constant humidity and heat are also favourable to the insects and fungi, which cause nearly all the diseases to which plants are liable, and for this reason neglect to take all precautionary measures that are possible, and dilatoriness in combating the evil when it has come, are more culpable and dangerous than in countries where alternate dry and wet seasons are in themselves deterrent to plant enemies.

"With all diseases, whether due to fungi, insect, or environmental causes, the "plant doctor"—*i.e.*, the mycologist or entomologist—cannot be expected to wield a magic wand at whose touch the disease disappears. These investigators, by their knowledge of the nature

of the evil which is attacking the plant, are in a position to devise the best means to attack fungi or insects, and prevent their having an easy prey. Such measures generally and continually carried on, result in the gradual decrease of the evil dealt with, and often their complete extermination."

Rubber in Malay.

The progress of rubber cultivation in the Malay Peninsula continues to be unique in its rapid progress and in the success of the areas already planted, and which have come into bearing.[1]

At the end of 1908 there were 37,440,020 trees as compared with 27,558,369 a year before; 60,636 acres were planted during 1908, an increase of over 33 per cent. on the previous year, giving a total of 241,138 acres of rubber on December 31, for the whole Peninsula.

The output of dry rubber increased in 1908 by 56 per cent.: 3,539,922 lb., or 1,580 tons, being produced as against 2,278,870 lb., or 1,017 tons, in 1907. This 1,580 tons re-

[1] *Straits Settlements Bulletin*, September, 1909.

presents probably about $1\frac{1}{2}$ per cent. of the world's supply for 1908. The average at which this was sold was not less than 4s. per lb., representing an export of over $6,000,000 in value or over £700,000; eight years ago the value of rubber exports was about £1,700, a large and profitable industry having been created within that time, which will next year show a return of produce worth more than £1,000,000 or $8,500,000.

RUBBER STATISTICS, MALAYA, UP TO DECEMBER 31, 1908.

	Federated Malay States	Straits Settlements and Kedah	Johore	Kelantan	Total
Number of estates	300	81	27	9	417
Acreage in possession	455,596	158,553	127,959	20,300	762,408
Acreage planted up to December 31, 1908	168,048	50,121	20,944	2,025	241,138
Acreage planted during 1908	41,813	7,255	10,818	750	60,636
Number of trees planted up to December 31, 1908	26,165,310	7,743,322	3,224,388	307,000	37,440,020

RUBBER IN FEDERATED MALAY STATES.

The advance of rubber planting in the Native States was as rapid in 1908 as in 1907, the drop in prices not causing the cessation in

opening up and planting that some expected; 41,813 acres were planted during the year as compared with 30,743 in 1907, an increase of 33 per cent., a third more than the total acreage. (See table of statistics, p. 340.)

On December 31, 1908, there were 168,048 acres of rubber, containing 26,165,310 trees, in the Federated Malay States, as against 126,235 acres and 19,628,957 trees on the same date of the previous year.

Within the last ten years the acreage of rubber has increased 100 times, and it has practically doubled during the last two years.

The output of dry rubber increased by 60 per cent.: 3,190,000 lb., or 1,425 tons, as against 1,980,000 lb., or 885 tons, in 1907. These figures of output are slightly higher than those given by the Commissioner of Trade and Customs of the amount of rubber exported; this is due to the fact that rubber recorded as produced on the estate before December 31 is exported later and comes into the export returns for the following year.

There is no better proof at the present time of the energy and grit of the British planter in the Tropics than the excellent manner in which

this large acreage of rubber in the Federated Malay States has been felled, cleared and planted, and is now in healthy and vigorous condition, and, where old enough, yielding handsome profits. Great credit is due to the managers of rubber estates and their assistants for carrying out their varied and arduous duties, under conditions frequently unfavourable, with so much success.

Since 1908 we have, of course, had the rubber boom of 1909 and 1910, and we all know that during the next ten years, even if but 50 per cent. of the promised extension is carried out, the figures given above will shrink to comparatively small dimensions. But there is a great difference in what has been achieved and what one wishes to achieve. For the ordinary planter, therefore, out of Malaya, I would say that the figures given above will be quite sufficient to go by; far better a wooden hut on the firm ground than a *château en Espagne*, and the figures given above of the work done in Malaya shows an industry that can add, and is adding, greatly to the purchasing capacity of the Tropics of our manufactured goods in return for their rubber; an industry, one cannot

RUBBER STATISTICS, FEDERATED MALAY STATES, UP TO DECEMBER 31, 1908.

	Selangor	Perak	Negri Sembilan	Pahang	Total
Number of estates	130	114	42	14	300
Acreage in possession	215,509	140,675	79,625	19,787	455,596
Acreage planted up to December 31, 1908	82,246	56,706	27,305	1,791	168,048
Acreage planted during 1908	20,694	10,539	9,649	931	41,813
Number of trees planted up to December 31, 1908	12,499,331	8,560,321	4,923,745	181,913	26,165,310

COMPARATIVE TABLES OF RUBBER ACREAGES AND TREES IN MALAYA, 1907 AND 1908.

	State	Rubber acreages		Number of trees	
		1907	1908	1907	1908
F.M.S.	Selangor	61,552	82,246	9,648,093	12,499,331
F.M.S.	Perak	46,167	56,706	6,648,957	8,560,321
F.M.S.	Negri Sembilan ...	17,656	27,305	3,165,388	4,923,745
F.M.S.	Pahang	860	1,791	166,590	181,913
S.S.	Malacca	36,946	41,324	6,019,940	6,556,792
S.S.	Province Wellesley	5,920	8,797	767,276	1,186,530
	Johore	10,126	20,944	1,142,196	3,224,388
	Kelantan	—	2,025	—	307,000
	Total ...	179,227	241,138	27,558,440	37,440,020

In Province Wellesley is included two estates in Singapore, eight estates in Penang and five estates in Kedah. These figures are approximate.

help feeling, that has brought much more general wealth and comfort, and less disappointment and loss, than 99 per cent. of the world's gold-mines. Let us all work, therefore, to further push on this opening up and development of the Tropics, for the produce will always find a ready market, and our trade will benefit the manufacturers, workpeople, and, in fact, all classes.

But all this success has only been brought about by the unceasing care and attention on the part of the planters in the first place, and of the Directors of Agriculture, the Government entomologists and other members of the Botanical Department staffs both up at Kuala Lumpur and down at Singapore. Mr. Gallagher, who until lately was Director of Agriculture at Kuala Lumpur, but was Government Mycologist in 1908, when Mr. J. B. Carruthers was Director, even then called serious attention to the trouble that *Fomes semitostus* was giving at the time to planters, when he said:—

"Pará rubber (*Hevea braziliensis*), the principal cultivation owned by Europeans, has been fairly free from fungi during the

past year, except of a disease which attacks the root, finally killing the tree. This is widespread. There was probably not an estate free from it, some suffering more than others; but the percentage of trees affected is everywhere comparatively small. The disease is caused by *Fomes semitostus*, and is reprobated as much for the extra labour demanded to suppress it as for the actual loss in trees it causes. I published a paper in the *Agricultural Bulletin* for November, 1908, describing the disease and advising measures for its prevention. It is viewed with alarm by many planters, but if the directions I have laid down for its treatment are followed, it will ultimately be stamped out. In fact, I believe that its method of infection, combined with the energy which most planters are exhibiting in grappling with it, if strenuously continued, will ensure its disappearance from all plantations before the trees are four years old.

"Many trees were lost through wound-fungi which obtained an entrance through a wound made where a branch was broken or cut off, or where a wound has been made in some other way. Most planters now recognize

the danger of bare wounds and cover such with tar, but the practice is unfortunately far from universal.

"*Soil Acidity.*—Many complaints of diseased plants were found to be due to excessive acidity in the soil. This source of trouble is fairly common on the humus-rich peaty soils of the Coast districts. I referred to it in my 1907 report. Coffee suffers also. Good drainage and the application of lime usually neutralize the soil sufficiently. Experiments to reduce this acidity by means of phosphates are being carried on; pending the results of these, I recommend the application of lime to such soils.

"*Manurial Experiments.*—Queries occasionally reached the Department regarding the application of manure to rubber trees. The soil concerned had generally been worn out by coffee or tapioca, and frequently had suffered much from wash. To gain some information on this point, early in the year I began experiments on two estates with artificial manures. Results have been accumulated, but they are not complete enough yet for publication."

According to the *Straits Bulletin*, *Fomes*

semitostus can be cured by drainage and application of lime, as has already been done on tea and coffee lands. Basic slag on this account might well be experimented with, for whilst correcting the soil it can nourish the trees and help to increase their vigour and so render them less liable to disease. The importance of adequate drainage and cultivation at the same time must not be lost sight of.

It is, however, important so far as a Contagious (Plant) Disease Act is concerned against *Fomes*, that planters should make use of the battle-cry, "Prevention, not Cure." The authorities want to see to it that no stone be left unturned to *prevent Fomes* from breaking out, otherwise the careless planter will not trouble, but trust more to the possibility of curing the evil than to the necessity of altogether preventing its making its appearance. This is to be avoided, for even were the careless planter to cure the outbreak on his own lands, he might still be the direct or indirect cause of its spreading elsewhere. I think it was Mr. Gallagher who maintained that drainage is not always a "cure," otherwise why, he asks, is the fungus so common on dry hillsides?

Mr. H. C. Pratt, the Government Entomologist, at the same time shows in the *Straits Bulletin* for September, 1909, how busily he was kept, even in 1908, coping with the pests that were found attacking the rubber trees; what the work of his department will be in the time to come it is easier to imagine than describe. Many of the planters in the East are, as is well known, doing their utmost to keep their lands as free from pests and fungus as cultivation and spraying can make them, and if the new companies will work or are made to work on the same lines, their united action will go a long way to reduce any threatened outbreak to within remediable bounds, especially if, as I have advocated elsewhere, belts of forest trees are left, or others are planted to restrict disease and pests that affect the rubber plantations. Among the pests enumerated by Mr. Pratt were the following:—

"During the past three months, October to December, 1908, the increase of entomological work is about 100 per cent., and there is a great deal to be done in studying the life-history of those insects which have been sent to the Agricultural Department as pests of

major or minor importance. Only those which have been doing considerable harm will be mentioned in this report. Since my transference I have been chiefly engaged in a study of *Termes gestroi* on the Pará rubber tree. The life-history of this insect will be published in one year to eighteen months, while a paper for the planters on the best methods for eradicating the evil has been written and will be published as soon as the blocks of the sketches already sent to Calcutta are returned.

"The important question of rendering houses white ant proof has been discussed, and with a view to obtaining reliable information in connection with this, a series of experiments has been commenced. Four hundred pieces of wood of four kinds have been treated with various chemicals of different strengths and in different ways. These have been buried near the golf course in Kuala Lumpur with 150 controls. Termites of various species are known to be abundant in this land, in fact I should estimate that two-thirds of the ground wherein these woods are buried is undermined by termites. It is proposed to take up these woods at periods of 2, 6, and 9 months, 1, 1½, 2,

$2\frac{1}{2}$, 3, $3\frac{1}{2}$ and 4 years, after which time a certain number of pieces will still remain. In all, there are 37 experiments, and for each experiment ten or more pieces of wood have been treated. The first series of these woods, after two months' burial, have been taken up, and it is hoped that these together with the second lot can be exhibited at the Agricultural Show to be held at Penang during 1909.

"Negotiations are in progress with the Government for the treatment on a large scale of the timber to be used in the construction of houses in Kuala Lumpur.

"Of other rubber pests, *Eumeces squamosus* (a weevil) has been sent in from the managers of some ten estates in the Federated Malay States, who report that at times it does considerable harm to the young rubber trees by eating away the older leaves and young shoots. Collecting the beetles by hand has proved to be effective. The beetle is practically omnivorous, and it is not likely to confine its attacks to rubber, but will continually appear and attack small areas of the young rubber trees. A report on this insect, under the name of *Astycus lateralis*, appeared in the *Perak Museum Notes*, vol. ii., pt. i., p. 61, by Wray.

"Towards the latter end of the year several complaints were received relating to a small borer in the rubber trees. An examination of the insect proved it to be closely allied to the shot-hole borer of Ceylon, but as I have no technical description of this insect, which belongs to a family composed of closely allied species, I am not certain of its identity. I am under the impression that it is *Xyleborus parvulus*. Be the insect *Xyleborus fornicatus*[1] (the shot-hole borer) or any other species there is not the slightest doubt why it has gained a footing in some places. Several estates have lately adopted pollarding, and it is invariably on these pollarded trees that the insect commences to be destructive. Transference of the insect to those healthy rubber trees planted near pollarded ones is rare, although this does occur, and the only word of warning necessary is to abandon pollarding, which after all is not remunerative. When thinning out is necessary the tree should be completely done away with. When apparently healthy trees are attacked, the borer

[1] Hart points out that the shot-hole borer in Trinidad is *X. perforans*.

usually makes its entrance into the tree on the tapped surface, although I have seen on one occasion a tree affected below a side branch.

"The majority of these insects are caught in the latex and killed; their presence may be detected by latex exuding from the tree, and running down the bark in thin strings.[1]

"The question of lopping must also be noted. Where it is necessary to do this, it will be well to place tar on the wound immediately after the branch is cut. It is useless waiting a couple of days; one coolie, with the tar, should follow each man who is lopping and the application should be made immediately.

"Three species of lepidopterous larvæ have been reported to this department as defoliators of rubber. In places they have done considerable harm, but I have been unable to make personal observation in connection with these pests. No specimens were sent, and I therefore know nothing more than the fact that they were caterpillars. Here it can be pointed out that it is essential for planters to send specimens, and when possible alive. They may be placed

[1] Mr. Hart reports that in Trinidad a certain black bee attacks the rubber trees for their latex.

in a cigarette tin, in which are punctured a few holes, with the leaves they are feeding on. Do not keep them in this tin for several days before dispatch, as they will arrive dead, and very likely in a putrefying condition, but send them off immediately. Where living specimens cannot be sent, place a few in spirit. Observations should also be forwarded. These defoliators will have to be studied during 1909, should they reappear.

"A species of *Acridium* (grasshopper) is reported from two estates as eating the Pará rubber leaves. As both of these places are planted up with crotalaria I was inclined to think that this plant encouraged the pest, and from the following letter it appears that this cover plant may do so: 'The height of the crotalaria varied from 3 ft. to 7 ft. according to whether it had just been topped or not. The rubber was planted in May last and crotalaria put in in July; the trees which got away well and have their heads above the crotalaria are badly eaten as per specimen sent. Again, those trees which are more backward have no leaves at all, simply the straight stem with a very small shoot on top. The grasshopper does

not, as far as I can see, feed on the crotalaria, but only the rubber leaves.'"

In reviewing the general system of the work undertaken by the Departments of Agriculture in the East engaged in investigating the causes of diseases, and carrying out experiments to cure those that have appeared, and to prevent others from coming, one cannot help feeling how very much can be done by the planter himself to keep his lands and trees free from trouble, even if he has not the plant doctor at hand like his more fortunate brother planters elsewhere; any English planter, however, can send specimens of the disease or pest to Kew or other station and get it named, and a remedy suggested, and if he follows on the lines adopted by the Eastern scientists, he will, I feel sure, find that his crops turn out much better than those of his more careless or indifferent neighbour.

We were told by Mr. Carruthers that "all efficient measures for the preservation of health rest upon exact knowledge of the causes of disease and the effects they produce in their victims, and we have now an immense number of instances of accurate tracing by observation of the cause of plant diseases.

These have been accompanied by experiment, and it needs no argument to convince anyone in the least acquainted with inductive science that experiment is as essential as observation. During the past twenty years, the discoveries in plant doctoring have made almost a revolution in agriculture, though this is seen more in Europe and America than in tropical countries.

"The general laws of sanitation for plants do not differ to any great extent from those laid down for man and animals. They consist in the removal and destruction by burning of all dead plants and dead parts of plants, the prevention of conditions which favour the progress of the disease, and the isolation by means of trenches of plants whose roots are diseased.

"These methods cannot be adopted without an intelligent watching for the appearance of disease. *And the importance of a stitch in time is in nothing more evident than in the fight against plant diseases*,

"A case was brought to my notice of an outbreak of a caterpillar which had taken some time to entirely destroy all leaves on the

"belukar" adjoining a rubber clearing, and only when the caterpillars, which were in immense numbers, had been driven to eat the rubber was any action taken.

"The aid of the technical experts of the Department of Agriculture should be sought as soon as any pest is observed, but the destruction of as many of the caterpillars, insects, larvæ, cocoons, &c., as can be found should be at once undertaken.

"Every properly equipped estate should possess the means of combating as early as possible all diseases and pests, and should possess implements for pruning back the branches of big trees. For this purpose handy machines are made at the cost of a few dollars which easily cut at a height of 30 ft. branches 3 or 4 in. in circumference.

"Efficient spraying machines should be found, always in working order, in every estate store, just as the fire apparatus in a gallery of valuable pictures. The cost of even the most expensive steam power spraying apparatus capable of reaching trees of 80 ft. or more in height, bears an infinitesimal proportion to the value of the trees on even a small rubber estate.

"The materials for spraying should also be kept in stock, so that no delay is experienced when such work has to be done. My experience of over ten years' Eastern planting has been that the delay caused in getting weapons to fight the disease has often caused the task of getting rid of the pest to be much more difficult and expensive than it would have been had the estates been forearmed.

"Fifty years ago the conditions favourable to the rapid spread of disease caused by insect, fungi, or bacteria were not so great as at the present day" (*i.e.*, in 1908). To-day every acre opened up and planted, further tends to increase the risk of disease, "and the presence of 35,000,000 trees in an area of some 26,000 square miles is in itself a danger, but the weapons which the planters of that day possessed for an intelligent fight against these organisms were of little use and were wielded without confidence. In India the loss by wheat rust was some time ago estimated at £91,000,000, and in Ceylon the leaf disease of coffee caused the extinction of that industry, a loss of at least £15,000,000. The work done by sanitation and preventive medicine in pre-

serving human life are now historical facts; 200 years ago the mortality of London was 80 per 1,000; it is now about 20. Until a few years ago contagious pleuro-pneumonia and foot-and-mouth disease caused immense losses of cattle, estimated at 2,000,000 per annum, worth probably £30,000,000; they have now been almost exterminated. Plant sanitation and preventive measures can, if invoked, do as much for the preservation of cultivated plants, and with the knowledge we now possess it is impossible that any disease could so seriously damage a big agricultural industry as has been the case in the past."

Want of time has caused me to cut short the section of this book devoted to Diseases; as it is, I am two months later than I meant to have been in bringing it out, but was unexpectedly obliged to spend about that period in preparing and publishing another book[1] on the Tropics, that the legislation proposed in this country rendered necessary. Apart from this, however, kind friends abroad—and I do not say this sarcastically—have sent me so

[1] "Aigrettes and Birdskins" (Bird Protection in the Tropics). Price 5s. London: John Bale, Sons and Danielsson, Ltd.

many reports, special pamphlets, books, &c., to consult (all of which proves how a really good book on international lines is needed in connection with tropical plant diseases, especially those affecting cacao, rubber, and coconuts), that I have been forced to pull up short, and to leave the rest for a future occasion. To those, however, who wish to continue where I leave off, I have much pleasure in referring them to the excellent books and pamphlets that I have before me, which include the circulars issued by the Royal Botanic Gardens, Ceylon, including :—

"Die-back of *Hevea braziliensis*," by T. Petch, B.A., B.Sc., &c., vol. x., No. 23, January, 1910.

"A Bark Disease of Hevea, Tea, &c.," by T. Petch, vol. iv., No. 21, July, 1909.

"The Stem Bleeding Disease of the Coconut," by T. Petch, vol. iv., No. 22, November, 1909.

"A Root Disease of Hevea," by T. Petch, vol. 5, No. 8, September, 1910.

"Brown Rot Disease," by T. Petch, B.A., B.Sc., &c., vol. v., No. 6, July, 1910.

"Miscellanea : chiefly Pathological," in *Tropical Agriculturist*, by T. Petch, B.A.

"Revisions of Ceylon Fungi," by T. Petch.

Bulletin of the Department of Trinidad, vol. ix., Agricultural Society, Port of Spain, Trinidad. Price 6d. No. 64, *re* "Rubber and Cacao," and No. 65, *re* "Canker in Cacao," are especially useful.

Agricultural News, Barbados (price 1d., fortnightly), is well worth filing.

The Bulletins of the Imperial Department of Agriculture at Barbados often contain reports and accounts of cacao, rubber and other experiments, so that I always keep it by me, as well as the *Proceedings of the Trinidad Agricultural Society* (vol. ix., No. 2, 1909, and vol. x, No. 4, 1910) both of which I have used on several occasions in this book.

Journal of the Jamaica Agriculture Society. Price 3d., monthly (Kingston).

The Agricultural Bulletin of the Federated Malay States. Price 13s., yearly. This is edited by Mr. Ridley, M.A., F.R.S., &c., who was very aptly described to me by a leading authority as the "father of modern rubber planting."

The (green-covered) Bulletins issued by the Department of Agriculture, Kuala Lumpur,

F.M. States, by Mr. W. J. Gallagher and Mr. H. C. Pratt, include "Coffee Robusta" (No. 7), "Root Diseases of Hevea" (No. 2), "Pará Rubber" (No. 10), "Coco-nut Pests" (No. 4), "Rats in Rice Fields" (No. 5).

The Journal of the Board of Agriculture, Georgetown, British Guiana (Quarterly). Price (locally) 1d.

The Philippine Agricultural Review (especially for Ceará Rubber), Bureau of Agriculture, Manila. Price 2 dols. gold.

Trinidad (W.I.) Agricultural Society (1907). Papers: No. 280 on "Cacao Pests"; No. 266 on "General Culture of Cacao"; No. 263 on "Cacao Shade"; No. 257 on "Cacao Pruning and Soil Management"; No. 253, "Preliminary Report on Cacao Pests"; all by O. W. Barrett.

Trinidad Bulletin, No. 63, July, 1909, includes many articles on "Rubber and Cacao and Cacao Soils, their Maintenance and Regeneration."

"Translation of the Witch-broom Disease."

Proceedings of Trinidad Agricultural Society, vol. ix., Part 12, December, 1909. 82 pp. with 18 photographs.

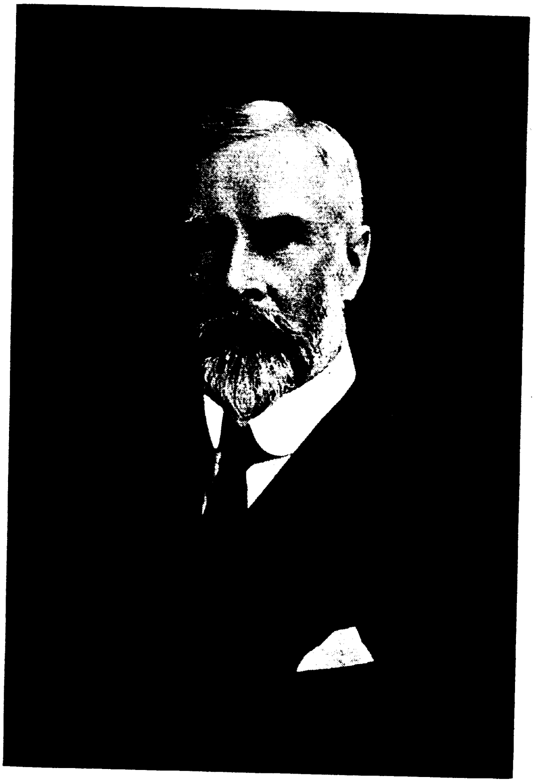
CASTILLOA RUBBER.[1]

By WILLIAM FAWCETT, B.Sc., F.L.S.

Late Director of Public Gardens and Plantations, and Deputy Chairman of the Agricultural Society, Jamaica.

PARÁ rubber (*Hevea braziliensis*) has supplied such a very large proportion of the rubber used in the Arts, the area of its natural *habitat* is so vast, and the tree has been planted so extensively, that the attention of growers of rubber has been mainly directed to experiments with it alone. But as the conditions for the successful cultivation of the Brazilian tree are not to be found everywhere in the Tropics, it is well to experiment also with other plants, and the most promising of these is perhaps the Central American rubber, a species of Castilloa.

[1] Vols. iii. and v. of *Tropical Life* (say for years 1907 and 1909) each contain a series of articles on Castilloa Planting which I thought at one time of including in this book. Finally, however, I had to abandon the idea, as the number of pages already are far in excess of what I meant them to have been.



MR. WM. FAWCETT.
One of our most reliable Castilloa experts.

Species.—Some species of this genus, *e.g.*, *Castilloa tunu*, are worthless as producers of rubber, and before using the seed of any Castilloa tree it is important to ascertain whether the latex of that tree yields rubber of good quality. *C. elastica* is the species that has been considered the main source of Central American rubber. Professor Olsson-Seffer thinks that *C. lactiflua* gives a more ample flow of latex. It is to be hoped that he will favour us with the results of further investigations.

Situation.—Experience in growing Castilloa under various conditions in Jamaica points to several factors as being important for the successful growth of the tree. It will not grow to advantage if the proportion of clay in the soil be too high, otherwise it does not appear to be very particular. A loamy soil is the most suitable. The drainage must be good; the unsuitability of stiff clays may be due to the want of sufficient drainage, and may perhaps be overcome by making drains. The rainfall should be at least 70 in. per annum; but if less, and the deficiency can be supplied by irrigation, the trees will grow and

yield quite as well. A temperature which varies between 70° and 90° F. is suitable; the elevation is not material if the temperature does not fall much below the lower limit.

Shade.—Castilloa trees are found in Nature on the edge of forests and in clearings. Overhead shade is not requisite in the wild state, and has not been found essential in most plantations; but in some districts it has been considered advisable to leave about four high trees to the acre to help the young plants in the dry season. The stem requires some protection from the sun, but this can be provided in plantations by the shade of the neighbouring trees. Overhead shade is not detrimental if not too dense, but it lengthens out the bole of the tree unnecessarily.

Clearing Ground.—If woodland has to be cleared, this operation should be done thoroughly from the first. Some recommend that a few trees should be left here and there to afford shade for the seedlings and young trees, but they must be got rid of eventually, and the cutting down and removing them leads to injury and destruction among the rubber trees. The large trees should be sawn

into boards for the erection of sheds at a later period; the smaller timber will be useful as posts; the small useless branches should be heaped and burned in such a manner as not to set fire to other trees or bush close by. The ashes are good manure.

Distance apart and Catch Crops.— The distance at which Castilloa trees should be planted at first depends upon whether they are to be grown with bananas or other catch crop, or alone. If the soil is suitable for bananas, and the locality one where it will pay to grow them, no other catch crop is anything like as good. The bananas should be planted in March at distances of 15 ft. apart, and the Castilloa seedlings may be put out about September, each seedling in the centre of four banana plants, or if the cultivator or plough is used to keep down weeds the Castilloa must be planted in the banana rows between the bananas. The bananas may be grown for three or four years, and then they should be gradually thinned out, as the Castilloa trees spread their branches. If bananas are not suitable, corn (maize) and gungo or pigeon peas (*Cajanus indicus*) may

be used as catch crops and temporary shade. The fields should be lined out in March, and stakes put in to mark where the Castilloa plants are to be put out. Then the gungo peas should be sown so as to leave a clear space of 4 ft. round the stakes, and the corn not nearer than 7 ft. The gungo peas will not last more than two or three years, but by that time the young Castilloa plants will not require any more nursing. The corn will not interfere with the Castilloa if kept at a safe distance, and if there is a market for it the returns will help to pay expenses. Even if there is not a market for the gungo peas, they will increase the nitrogen content of the soil, besides forming a slight shade for the rubber. The cultivation of the soil will be of the greatest benefit to the growing rubber plants. If no catch crops are to be grown the distance for the rubber plants may be 7½ ft. at first, to be thinned out eventually to 15 ft. apart; or, according to the practice in Mexico, the distance may finally be 12 by 10 ft., making 400 to the acre.

Seeds.—The seeds are massed together, and are covered with an orange-coloured flesh.

When ripe they drop from the trees, and if left undisturbed numbers of seedlings will soon spring up. It is best, however, to collect them as they fall, and sow them in a seed-bed. There should be no delay in sowing them, for they soon lose their power of germinating. Professor Olsson-Seffer was interested in some experiments to determine the best age at which to collect seeds from the trees. Until the result of these experiments is known I should advise that seed should not be sown from trees until they are fully six years old, when the latex has lost its resin.

Sowing Seed. — The seed-beds should be thoroughly forked and raked until the particles of soil are quite small and fine. The seeds should be lightly pressed down so as to be just covered by the soil, and at a distance of about an inch apart from each other. A thin layer of dry grass may be scattered over the bed, and then a good watering given from a watering-pot with a fine rose. The soil should afterwards be kept only just moist, not too wet, and carefully weeded. When the seedlings are 3 or 4 in. high the soil may

be loosened with a fork and the seedlings taken out, and either planted again in boxes at a distance from each other of 3 in., or set out at once in their permanent places in the field. If they can be constantly inspected in the field and kept weeded, and the weather is favourable, it is better to put them out at once; but if not, they may be kept in the boxes until they are 6 or 7 in. high, and then transplanted, when they are not so liable to be the worse for any neglect in the open. It is still better to sow the seeds at once, as soon as they fall, after they have been carefully selected, in the permanent positions already marked out for them in the field. Five or six may be sown at the stake in a circle, at about 10 in. from the stake.

Planting Out.—If bananas have already been planted during the previous March, the fields should meantime have been run over with the plough or cultivator to keep down weeds, and to establish a dust mulch on the surface. The seeds may be sown as they fall, or the young plants may be put out about September, either in the rows between the bananas, so as to be 15 ft. apart when the bananas are removed,

or they may be planted each in the centre of four bananas.

Thinning Out.—If the seeds have been planted at stake, the seedlings should be continuously watched and carefully thinned out at each weeding, leaving at the end of the first six months about half the number. If none of the five or six have turned out well, supply from the nursery which has been made for the purpose, or from a neighbouring group.

Olsson-Seffer states that on La Zacualpa plantation they thinned the rubber stand every year until the third year, when they had about 800 trees to the acre. During the fifth year they tapped half these trees, selecting the poorest, and leaving the best trees untouched. After heavy tapping those that have suffered are felled; after four months those that had not suffered are finally tapped. At the end of the sixth year there are 400 permanent trees to the acre.

YIELD OF CASTILLOA.

By H. Hamel Smith.

As to the yield from Castilloa trees, this seems to vary from *nil* to 5 lb. per tree, according to published reports. What can be relied upon as an average yield per 1,000 trees on a large estate, say of at least 250,000 trees, no one can say. No rubber needs such careful and continuous research work in order to ascertain once and for all time what it will yield, than Castilloa. At present, acres and acres have been planted, in centres where the climatic and soil conditions are entirely different, and the returns have been most unsatisfactory. A dozen experts are no doubt ready to explain the reason as follows :—

A tells you that you planted the wrong kind of seed ; and yet such well-known planters are alleged to have done this, that one feels if the charge is true, that there can be no appreciable difference between the seeds. Even if there is a marked difference, some maintain that the *C. elastica* is the best ; whilst others say that it is not as good as the *lactiflua*. All agree only that a kind called *C. australis* is no good.

B. tells you the seed is good, but the soil is wrong, and claims to prove his statement by pointing out where miles of Castilloa trees have been planted, perhaps are growing luxuriantly, but giving no return. In spite of these mulls, no one seems able to point out any large Castilloa estate that has absolutely the right soil, and where the trees are giving certain and regular returns like Pará trees do.

C. tells you point blank that no variety of Castilloa, neither those you hear spoken well nor ill of, can be cultivated to pay. That it is essentially a forest-loving tree, and will never yield freely, certainly never give its full yield, as a plantation tree.

Meanwhile, you cannot, in spite of all the failures, and of the experts so ready to explain the cause, give reliable figures as regards the yield of Castilloa, beyond experimental tappings here and there. Such information would be out of place in a standard work like this, so I will not attempt it. Much has been said about the difficulty of ascertaining how much rubber per tree can be looked for from Ceará, but I consider that we are better off in regard to information about Ceará yields than of those from the Castilloa tree.

Elsewhere,[1] Mr. Casse describes how they tap Castilloa. Incidentally he claims that tapping on well-planted estates "becomes much less expensive than experimental tappings in botanical gardens." "Here, in Hayti," he explains, "we use men and boys for tapping. Each man has a boy with him and is supplied with :—

"(1) A light ladder, 5 ft. to 8 ft. long.

"(2) One German, one English tapping knife.

"(3) A number of small yellow metal cups with a sharp edge for fastening on to the bark.

"(4) A bucket of water for washing down the wounds.

"(5) A second bucket for the latex.

"It is rather an interesting fact that of the many tapping knives we have tried, not a single one would give satisfaction worked by itself, but a cut with a German knife, followed by a cut with an English knife, gives much satisfaction. With our young Castilloa trees, six and seven years old, the latex has all to be spooned down, but as soon as the trees get

---

[1] *Journal of Jamaica Agricultural Society*, p. 213, June, 1910.

a little older, it flows better. The seasons influence the flow very much, and it is safe to say that for each locality in which the tree is planted new experiments will have to be made. According to our experience, tapping can and must be repeated several times throughout the year, and one cannot expect to gather a large quantity from each tree at a time. The men pass rapidly from tree to tree, and are thus able to operate on a large number in the course of a day. Three or four days after tapping, the rubber which has coagulated on the wound is gathered, and disinfected with coal tar."

De Valda at "Las Cascadas Estate," Panama, reports getting 14 oz. to 15 oz. of rubber from his Castilloa trees, with only two tappings a year.

The Dumont Company reported this year :—

"We have now growing on the estate 1,500 Pará (Hevea) trees, 158 Castilloa, and 26,760 Ceará trees, three and a half years old. The Pará grows very slowly, and, as far as can be judged, the latitude and climate of the Fazenda Dumont are not suitable for this variety. The same may be said of Castilloa. The Ceará trees give good promise of success, but as yet are too young to tap."

By courtesy of the W.I. Committee Circular.]

PARÁ RUBBER IN BRITISH GUIANA.

The original trees were from Ceylon stumps.
3½ years old; 35 ft. high; circumference 14 in. at 3 ft. from the ground.

Mr. John Parkin, I think it was, who said that Castilloa can give only *ounces* of dry rubber per annum, whilst Hevea produces pounds, and he wants to maintain that after ten or twelve years, whilst the Hevea tends to increase, Castilloa is inclined to go back. Owing to the lacticiferous system in Castilloa, a larger amount of fluid exudes at the first tapping, but later on, when the bleeding is repeated, the Hevea will increase, and the Castilloa practically cease to yield. The *Proceedings of the Trinidad Agricultural Society* for June, 1910, include some notes on this matter at the end of Professor Labroy's (of the *Journal d'Agriculture Tropicale*, of Paris) review of Mr. John Parkin's paper on tapping Castilloa and Hevea, all of which must be studied when trying to arrive at reliable yields from Castilloa. Manihot rubber is a plant of the same family as the Hevea, and with a lacticiferous system almost identical, yet without wound response, which would appear to show that the response does not depend on the lacticiferous system. Some of my friends in Central Africa, and at Hawaii, seem to secure a satisfactory wound response from

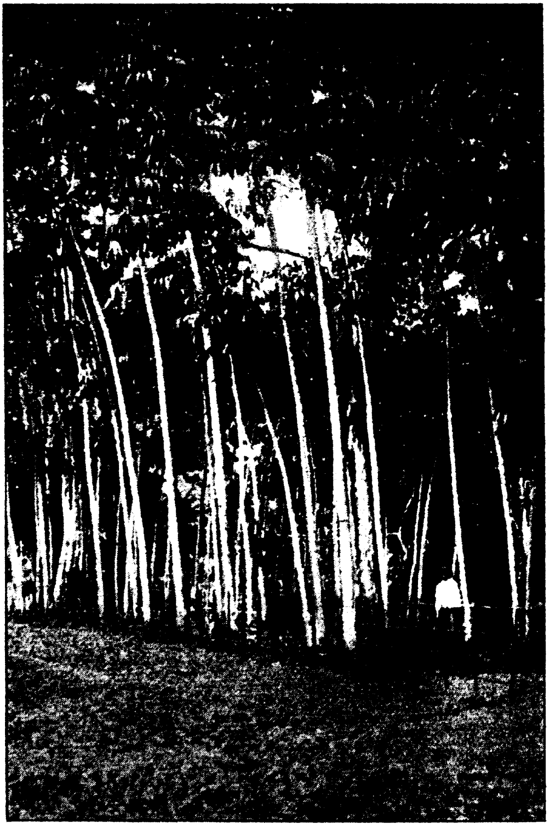
By courtesy of the W.I. Committee Circular.]

CASTILLOA RUBBER IN BRITISH GUIANA.

3½ years old; 21 ft. high; circumference 18 in. at 3 ft. from the ground.

Ceará trees, so the question of yield (*i.e.*, the amount of fluid exuding from the bark, rather than the percentage of caoutchouc contained in the fluid) seems to me to depend to a considerable extent on the soil and climatic condition about the trees. If the Castilloa, for instance, is growing in uncongenial circumstances, when planted on an estate instead of being crowded up in a forest, this would be quite sufficient to account for its decreasing yield after the tenth year. I am certain that it would well repay the rubber-producing world to send men to Brazil, to carefully and systematically study the three varieties—Hevea, Castilloa and the Manihots—growing amidst natural surroundings, to ascertain their actual yields, and, if an increase or a decrease is noted in some, to find out the reasons. By some such system only will the would-be planter of Castilloa or the Manihot rubbers be able to learn exactly what to expect from his trees, and if he does not get the expected results, to know the reason.

Meanwhile, surely the mania some managers have, and especially the American element in Mexico, for close planting is not conducive



Reproduced from the Trinidad, W.I. Bulletin.]

CASTILLOA ELASTICA AT ROYAL BOTANIC GARDENS, TRINIDAD.
Note the tall thin stems through being too closely planted.

to lasting yields of a satisfactory nature, as it naturally causes the trees to run up more like telegraph poles than anything else. Whether the tree is Hevea, Castilloa, Funtumia, Manihot, or any other kind, the owners in the long run must suffer, as its strength, to begin with, goes to make up the height, and secondly to struggle for very existence. If one could tap right up the trunk, then, of course, the results would be different, especially as when planted closely many more trees, of course, go to the acre, but as a man's reach is the limit for tapping, planters should seriously consider whether short trunks of large girth (surely also of thicker bark) will not in the end last longer, and prove more productive; whether, in a word, an acre planted 30 by 30 or 27 by 27, will not, at the end of twenty years, have given more rubber than if it had been planted 12 by 12 or 15 by 15. The question of close planting to economize weeding, &c., of course, has to be considered, but in most cases, even then, wide planting and a thicker girth deserve exhaustive trials, covering at least fifteen years of growth, before it can be said that close planting is preferable. At present close planting seems likely to prove

THE $1,000 CASTILLOA TROPHY.

Made by Messrs. Dieges and Clust, of New York, and offered by the *India Rubber World*, of New York, to be awarded at the International Rubber Exhibition (1911), London, to the best system of extracting Castilloa latex.

a mistake in the long run, especially as it discourages a thick bark.

Mr. E. V. Carey, the well-known rubber planter at the Straits, whose trees were planted 10 by 10, agreed that satisfactory as his yields were last May (some seven to nine-year-old trees, he claimed, were giving 7 lb. per tree),[1] yet thinning out would probably have to be resorted to, as, with close planting, the renewal of the bark later on becomes thin. This is due to the leaf and head of the trees being restricted when the trees are close, and the bark apparently thickens in proportion to the area that the crown of the tree offers to the sky.

CASTILLOA RUBBER IN MEXICO.

By J. L. Hermessen, of Chiapas, Mexico.

The southerly winds in Mexico prevail during the hottest and driest months of the year—namely, March, April, and May—and are a source of some anxiety to the planter up the Isthmus of Tehuantepec, constituting, as

[1] *Trop. Agric.*, June, 1910, p. 588.

they do, about the only menace he has to fear on the score of fire. During the same months much necessary work, impossible of accomplishment at any other period of the year—such as road and bridge-building—has to be attended to, including the preparation of areas for new plantings.

The selected block of forest is first underbrushed, then felled, making a complete clearing, which is allowed to dry for six weeks. Either at the beginning or middle of May the ground is burnt over, the choice of a favourable day for its operation being a matter of rather fine judgment. Hot, sunny weather, with a light breeze, is best; high winds naturally render the work very risky. As soon as the ground has cooled off sufficiently to permit of its being walked over, it is lined and staked for planting, which commences with the advent of the first rains in June, when about 4 in. have fallen. Five or six seeds are sown at stake, in a circle 8 or 10 in. from the same, the lines being 7½ ft. square, representing about 800 trees to the acre. Maize is frequently sown as a catch crop between the rows of rubber. Periodically, complete cleanings are

Plantation Landing on the Chalchijapa River, Isthmus of Tehuantepec, Mexico.

given to the ground during the first year, to afford the young plants air and space for development; and formerly such complete cleanings were continued at regularly extended intervals. The present general practice, however, is to clean only along the rows of rubber trees, after they have attained a height of 5 or 6 ft., leaving the natural "soft" growth to come up between them, with the twofold object of protecting the elongating trunks of the rubber trees—as they begin to cast their disarticulating branches—against scorching by the sun, and of providing shade over the surrounding surface of the ground, the effect being to limit, if not to wholly prevent, the spread of pernicious grasses, and tending towards a restoration of what is technically known as the "forest floor," in the form of an accumulation of leaf-mould, which is an essential requisite to the permanence of the lateral root system of Castilloa. Subject to such modifications as local conditions may suggest, this appears now to be accepted as the best treatment for Castilloa plantings, while having, in addition, the advantage of considerable economy over the older method of complete cleaning. Such

planting may then be properly characterized as one of *sylvan culture*, and it may be assumed that the application of the same to Castilloa would favour the theory of equilibrium in Nature, and thus minimize the chances of attack upon wounded trees by parasites, &c. In this connection it is interesting to note that Dr. Warburg, of Berlin, in his work "Die Kautschukpflanzen und ihre Kultur," makes reference to the fact that Mr. Millson, a former Government official in British Honduras, early pointed out the desirability of the sylvan system of culture for Castilloa, recommending just such procedure as is now being adopted.

The writer recently had the opportunity of witnessing a series of experimental tappings made upon Castilloa trees of six, seven, and eight years old, on an estate on the Isthmus of Tehuantepec. The crude method of tapping as practised by the native Indian, by cutting the trees with a "machete," has, of course, been superseded by the employment of specially designed tools. The knife used in the experiments here dealt with, was one invented by Mr. V. S. Smith, an American planter in the State of Chiapas. The incisions were made

in V form, but, instead of making a complete V, the cut on one side was stopped short of the other, to avoid introducing a possible focus of infection or rot at the meeting point, where moisture might be retained. A drip cup was attached to the base of the tree, by means of an upward cut made in the bark, the bottom of the cup resting on the ground. (The object of the *upward* cut was, of course, to convey the latex into the receptacle without waste.) In earlier tapping experiments a straight incision was also made between the centres of the V's, forming a regular herring-bone arrangement; this was, however, found to be a useless mutilation of cortex, increasing the risk of rot, as the mere drawing of a finger on the bark from V to V sufficed to establish a route for the flow of the latex down into the drip cup. The central cut, moreover, added little or nothing to the actual flow of latex, owing to the vertical structure of the lacticiferous cells in the Castilloa tree.

The latex collected in a fluid state in the drip cups was emptied into a large vessel at the expiration of the day's work and carried to the coagulating shed, where it was first run

through a fine wire mesh, to free it from mechanical impurities, such as bits of bark, lichen, moss, &c. It was then poured into upright, open-topped wooden barrels, and mixed with clean water in the proportion of one part of latex to four parts of water; thoroughly agitated for a few moments, covered with a lid, and allowed to stand over night. The following morning the latex was found to have risen on the surface in the form of a thick, almost pure, white cream. The barrels being provided with taps on the side at the bottom, the separated black water was drawn off until nothing remained but the washed latex, which was then ready for coagulation. A primitive method was here adopted in the use of the juice of a wild vine, known locally as "jamole," or "Morning Glory Vine" (*Ipomœa bona nox*), a member of the *Convolvulaceæ*, which grows in great abundance along the margins of the streams and rivers of this part of the country. Pieces of the riper stems of this vine, about a yard long, were cut doubled up several times, and macerated, to draw out the juice; the stems were then removed, squeezed out, and the remaining liquid strained. It was then

thoroughly incorporated in the latex by stirring with the same. Although many claims have been advanced in favour of the employment of certain chemical reagents to assist the process of coagulation, the superiority of such over the simple means above described has yet to be proved. In the course of an hour or two the caoutchouc globules would be found to have coalesced in the shape of a spongy mass, easily lifted out of the residual liquor. This mass was laid on a table and cut up into convenient strips, of about 1½ in. in thickness, which were immediately passed a number of times through the hard-rubber rollers of an ordinary wringing machine, the rollers being gradually adjusted until the strips had been reduced to about ½ in. in thickness, and containing the minimum (or, rather, the *advisable* minimum) of moisture; for, as with *Hevea*,[1] if too much moisture be taken out of the rubber, it results in a loss of elasticity and strength, the product becoming soft and gummy, if stored for any length of

---

[1] *Hevea braziliensis*, or Pará Rubber: Its Botany, Cultivation, Chemistry and Diseases." By Herbert Wright, A.R.C.S., F.L.S. Second edition. Colombo: 1906.

time, or subjected to pressure or a raised temperature; while, on the other hand, the retention of a large proportion of moisture is liable to set up putrefactive changes through the development of bacteria. The strips were next immersed for a few moments in clean water, to remove any traces of the extraneous black liquor; then taken out and hung up to dry on bamboo rods suitably arranged under the corrugated iron roofing of the drying shed. At the expiration of a month the rubber was ready for packing in bales for shipment. When the strips were freshly washed, ready for drying, they were about the colour of dough or very light putty; after a few days, however, they assumed a pale brown[1] superficially, but retained the original dough colour internally for an indefinite period.

Castilloa rubber prepared in this manner has been found to rank very high in quality for

---

[1] Mr. Parkin, in "Annals of Botany," London, 1900, says: "Several latices, which are pure white when they first issue from a wound on the plant, rapidly darken on exposure to the air. This is due to the presence of an oxidizing ferment, or oxydase, which, with the aid of the oxygen of the air, acts on some constituent of the latex, changing it to a deep brown colouring matter."

manufacturing purposes. Attempts have been made to produce what was thought would be a still higher grade by repeated washings of the latex until the residual liquor came off almost colourless, the latex being then transferred to shallow, porous earthenware pans and allowed to stand until atmospheric coagulation took place, requiring from five to ten days before the biscuit thus formed could be removed. The resultant product presented at the time, in all apparent respects, the most attractive example of Castilloa rubber. Later experience, however, has conclusively demonstrated the fact that rubber so treated becomes "tacky," and deteriorates much quicker than that obtained by the usual method; nor, indeed, does such rubber, upon removal from the coagulating pans, exhibit nearly the same strength of fibre and resilience. Just what the precise physical or chemical causes may be that contribute to these results must be left, of course, to laboratory investigation to determine.

It has been observed that in comparatively young trees, such as those referred to, the flow of *fluid* latex was less than in older trees; that

A Mexican Plantation of Castilloa, Six Years Old.

is to say, that immediately upon tapping the young trees, while a small proportion ran freely, atmospheric coagulation began very soon, the result being the formation of a creamy latex in the incisions, too thick to run, which in a few days could readily be stripped from the trees as "scrap" rubber, or "greña," as it is locally termed.

Much stress has been laid upon the danger, when tapping, of cutting through the cambium layer into the wood; and it cannot be denied that incisions around the circumference of a tree, of such depth as to penetrate the cambium layer throughout its entire length, is apt to cause rot, in which certain insects are likely to deposit their ova, the larvæ proving in many instances destructive of, or at least injurious to, the trees—this being particularly the case where the "machete" was used as the tapping instrument. But with a modern tool of such design as to prevent too deep an incision being made, it has been found that a cut just impinging upon the cambium layer, and piercing it only at intervals, has not only given the greatest amount of latex, but seems to be necessary to the formation of new bark. Any

Mexican Castilloa Plantation at Six Years.

incision failing to reach and penetrate, at intervals, the cambium layer will result in a mere hardening of the surface of the cut without any attendant renewal of the bark. It has been noted by many that the touching or cutting of the cambium layer effects a restoration or new growths of the bark within a period of sixty days, the bark continuing to grow and fill up the entire incision within a year.

Doubt still exists as to the best time of the year in which to conduct tapping operations. Mr. James Collins, in his Report on the Caoutchouc of Commerce, published in 1872 under the auspices of the British Government, states that in Nicaragua (where the climatic conditions are generally similar to those obtaining on the Isthmus of Tehuantepec) the most favourable time for tapping was during the months of March and April, when the change of foliage was taking place. The following quotations from Mr. O. F. Cook's monograph on Castilloa[1] also bears upon the

[1] "The Culture of the Central American Rubber Tree." By O. F. Cook, Botanist in Charge of Investigations in Tropical Agriculture, United States Department of Agriculture. Washington, 1903.

point: "The indications are that (internal) pressure attains its greatest intensity in trees which are exposed for a part of the time to a relatively dry atmosphere, and which are accustomed, as it were, to pump water rapidly to supply the leaves. Such trees may, on the contrary, yield no milk at all when the water supply is deficient. It may be expected, therefore, that open culture will require much more careful attention at the time of tapping." The best results, thus far, have been obtained on the Isthmus of Tehuantepec from tappings made during the early months of the dry season (February and March), before the weather has become very hot and when the coolest nights and mornings occur. In April and May, when the maximum temperatures of the year are attained, the deciduous character of Castilloa becomes most marked; and this is the period during which the tree is generally supposed to be in its most quiescent state, and to have the least recuperative power. On the other hand, in the wet season planters are confronted by the physical difficulty of collecting the latex. Some contend that tapping can best be done during the occasional

Castilloa elastica, Rubber Tree, Two Years Old, on an Estate in Davao, Philippines.

(and very uncertain) rainless spells of the wet season; and it is upon this latter hypothesis that two tappings per year for Castilloa come within the range of possibility. It has been noticed that the latex is in a much more fluid condition during the early morning hours; turgescence increasing as the diurnal heat reaches its maximum.

What the financial promoter and expert prospectus writer has long since settled to their own entire satisfaction and that of a trusting public, with the same fatuous positiveness as your orthodox theologian dogmatizes on the future life, viz., the question of *yield*, is still to the planter, who should know most about it, largely a sealed book. If he be honest, he will confess that he knows as yet very little about it. What he *does* know, however, is that a six-year-old tree will not give 1 lb. of rubber. Trees of unknown age, in a state of Nature, have yielded as much as 4 and 5 lb. of rubber at one tapping: and there are apparently well-authenticated records of yields of triple that quantity from very large and, presumably, very *old* trees. Undue weight seems to have been attached to the

generalizations of Herr Th. F. Koschny, of Costa Rica, in this respect. His claim, for instance, of a yield of $3\frac{3}{4}$ lb. of rubber from wild trees, 8 or 9 *years old*, must be accepted *cum grano salis*.[1] There are, as a matter of fact, no recognized means of definitely deter mining the age of wild rubber trees; the all-important element in the case in point is, therefore, hardly more than one of conjecture.

With regard to cultivated trees, whose ages, with very few exceptions, have not yet passed the eighth year, there appears to be a strong disinclination on the part of planters in Mexico to tap their trees to the full extent of their possibilities, owing mainly to a reasonable fear that permanent injury may result through incautious tapping in the light of present knowledge; and since, in the case of Castilloa, as with all caoutchouc-producing genera, notable constitutional differences occur, both as to size of tree and yield of latex, under similar cultural conditions, the results obtained from individual trees do not form satisfactory evidence upon which to base a conclusion as to the

---

[1] O. F. Cook, *loc. cit.*

average yield of many thousands of trees of like age. Hence, trial tappings of single trees, or groups of limited number, of equal age, vary very considerably. Thus, we have trees, or groups of trees, producing 1, 2, and 3 oz. of rubber, others ranging as high as from 4 to 6 oz. at one tapping. With such variable data to go upon, the difficulty of arriving at a true average yield for a planting of perhaps half a million trees is obvious.

Tentative experiments made in this district would indicate that trees grown under the most favourable conditions of soil, &c., may be tapped twice a year with equal results; but it would seem premature to say with assurance that the trees covering a large area could be safely subjected to such a drain upon their vitality until they had attained a greater age. To repeat, however, selected groups of trees of the age above mentioned have withstood a second tapping in a year without visible injury.

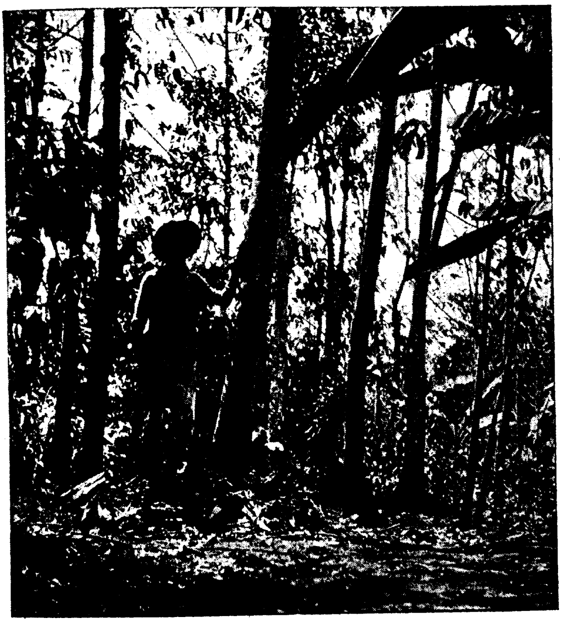
With regard to local soil conditions, it has been stated that "the oldest portion of the Isthmus evidently began its superaquatic existence at a comparatively recent period—

geologically speaking";[1] and that much of the geological formation of the Eastern Atlantic versant of the Mexican Cordillera towards the Isthmus of Tehuantepec is of similar late origin, is indicated by the presence of stratifications of marine shells and primordial ooze, where subsequent aqueous erosions have occurred, creating, in the cycle of topographic changes, more or less abrupt undulations, ridges and valleys, with occasional hills reaching to a height of 150 ft. between depressions. In the immediate neighbourhood of the sea and the riverine ėstuaries, alluvial deposits are found, but these have proved unsuitable for most cultural purposes, owing to the shallowness of the water-basin. On the approach to the sierras, "mesas," or benchlands, occur of an entirely different structure, these being made up of granite or other primitive detritus, incorporated with abundant vegetable matter. Such lands, unfortunately, are not encountered in any large area. The

---

[1] "Report of Explorations and Surveys for a Ship Canal by the way of the Isthmus of Tehuantepec." By Robert W. Shufeldt, Captain United States Navy, Washington, 1872.

soil of the district herein referred to is composed of clayey loams overlain in parts with



PLANTATION CASTILLOA, EIGHT YEARS OLD, SHOWING V-TAPPING INCISIONS.

beds of rich black humus of the greatest fertility.

The climate of the Atlantic side of the

Isthmus of Tehuantepec has three well-defined seasons—namely, the wet season proper, commencing usually the last week in May or the first week in June, and continuing till the end of October; the lighter wet, or "norther," season, extending over the months of November, December, January, and February; and the dry season, comprising the months of March, April, and May. The annual rainfall is between 90 and 120 in., with a very favourable distribution, three-fourths of the total precipitation taking place between June and October, while from then on until the approach of the dry season frequent showers fall, with much mist and drizzle. No month of the year is wholly free from rain, occasional light showers occurring even during the height of the dry season, when the greatest heat of the year is experienced, the mercury fluctuating between 80° and 90° F. in the shade, and sometimes marking 100°. An appreciable diminution in temperature ensues during the wet months, the average range being from 75° to 85° F., while during the cooler months, from November to February, the average temperature is between 60° and 80° F., once

in a while falling as low as 55° F. in the early hours of the morning. The lowest temperature recorded by one observer over a period of nine years was 50° F., this occurring in the month of January. The relative salubrity of the climate of the Isthmus of Tehuantepec as a whole, as compared with that of similar latitudes elsewhere, is quite remarkable, this continent being cooler under the Equator than any other, owing to the expanse of sea surrounding it and the more elevated configuration of the land.

The vegetation of this region presents to the trained eye a strictly tropical aspect, the forest growth consisting almost entirely of tropical genera, such as mahogany, Spanish cedar, lignum vitæ, giant representatives of the ficus family, the stately ceiba, with its wide-spreading, buttressed trunk; numerous examples of sapotaceous trees, including the lofty "mamé" and the "chicle" (from which American "chewing-gum" is made, and which also produces one of the best of all wild tropical fruits, namely, the "zapodilla," or, in the vernacular, "chico zapote"); while many anonaceous trees occur, some of which bear

edible fruits—close relatives of the famous custard apple, or "cherimóya." Hard-wooded shrubs of various orders and large-leaved plants form the undergrowth, with scattered groups of delicate, slender-stemmed palms, belonging principally to the genus *Chamædörea.* Sheltered in the ravines, and generally near the edge of a watercourse, tree ferns add their feathery beauty to the leafy labyrinth of the jungle, notwithstanding the low elevation of 300 ft. above sea-level. Clustering in the more open parts, and fringing the banks of rivers and streams, are groves of tall, graceful palms, including *Attalea cohune* and the spiny *Acrocomia;* while now and then a royal palm (*Oreodoxa regia*) rears his noble head over legions of lesser kind. (The writer is informed by a friend, who is more than an amateur botanist, that he has identified fourteen indigenous specimens of palms on the Isthmus of Tehuantepec.) Interlacing with fantastic festoons the upper branches of high trees, or reaching, like the halyards of a ship, to the earth, are great lianas, or climbing vines, which, when in flower, display enchanting colour effect, cloth-

ing the tops of the highest trees with brilliant mantles of purple, yellow, and crimson. These

CASTILLOA TREE IN SAMOA, FIVE YEARS OLD.

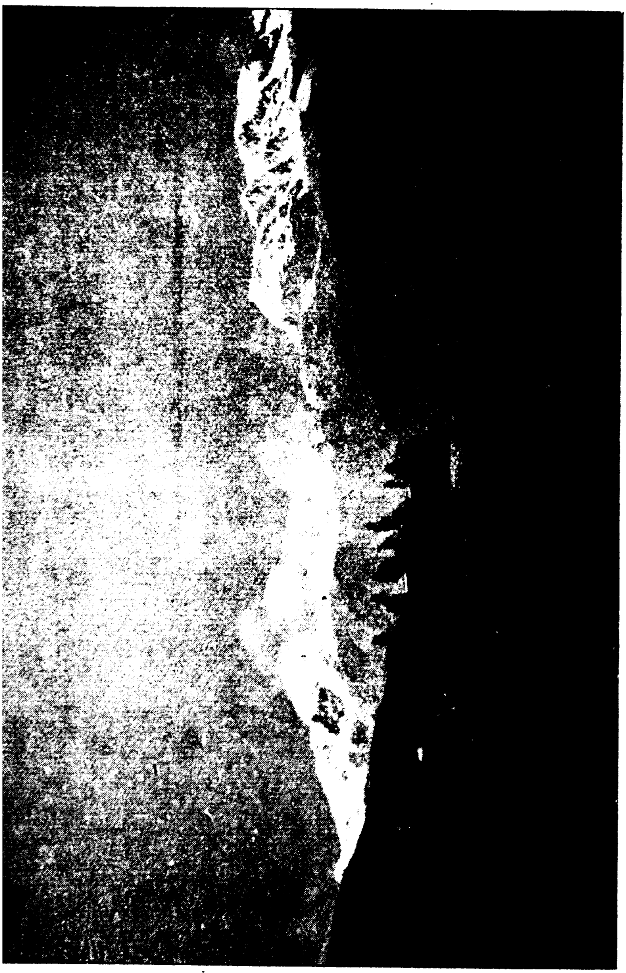
seem to be made up chiefly of representatives of the *Leguminosæ* and *Bignoniaceæ*. Many

trees, again, are adorned with a profusion of epiphytic growth—ferns, bromelias, and orchids. Amongst the latter may be found *Chysis bractescens*, with its beautiful, waxy-white sepals and petals, and labellum tinged with yellow ; the pretty and fragrant *Epidendrum atropurpureum*, *E. cochleatum*, *E. alatum*, *E. radiatum*, and *E. stamfordianum* ; a species of *Oncidium* very similar in foliage and inflorescence to the well-known *O. cebolleta* (found at higher altitudes in Mexico) ; *O. luridum*, *O. sphacelatum*, one or two showy species of *Stanhopea*, and a number of other genera of merely botanical interest. Four indigenous species of vanilla, including *V. planifolia*, also have their habitat in these forests. No attempts have been made, however, to cultivate the plant here.

RUBBER TAPPING IN BOLIVIA.

By F. J. Dunleavy.

The lands on which the trees which I am describing are situated in the San José estate, Antiqua Roma, La Nueva Paz, Bolivia, located along the Kaka and Beni Rivers, which comprise the upper branches of the Madeira River, one of the largest tributaries of the Amazon, Its southern boundary begins on the west of the Kaka River at a point where the Uyapi River joins with the Kaka, and runs 5 leagues up the Upapi, and from there running north parallel with the Beni and Kaka Rivers to a point 5 leagues up the Quendeki River, from where it joins with the Beni River on the north boundary. The boundary on the east side of the Kaka commences at a point where the Tomachi River empties into the Kaka, and runs 2½ leagues up the Tomachi, and follows a parallel line of the Kaka river at this distance as far as



View Behind Mr. Dunleavy's Residence, near Sorata, Bolivia, showing the Snow-capped Andes or Cordilleras

the Chamelo Chico, on the northern boundary of this part of the concession. The River Kaka changes its name at the junction of the La Paz River, and below this point is called the Beni, so that the main navigable river running through the lands I am describing is called both the Kaka and the Beni.

The rubber here, as in Brazil, is worked on the "estrada" system. Up to the time that I made these notes there had only been exploited one kind of tree, the *Siphonia braziliensis*, which is the same as the *Hevea braziliensis* or Pará rubber. Others would be worked were the question of transportation not so difficult, and when that trouble is solved, which it will be in the near future, the exploitation of other varieties of rubber and many other products will become a profitable industry. A calculation of the number of Hevea trees that are of an age for tapping, on the property that I am describing, is not less than 500,000, of the species known here as *Siphonia*, and which supplies the well-known Mollendo rubber of commerce, the rubber being mainly sent to Europe and America over the Andes, and by way of the Peruvian port of that name (Mollendo).

There are, however, in the neighbourhood, other kinds of Hevea, which were still unexploited on a larger scale up to the time of my leaving, but I can still give details of experiments with this new species of Hevea, together with particulars of the various systems of tapping the different kinds of trees. The work is mainly done by the Indians of the "Lecco" tribe, who reside on the estate. The territory I am describing is wonderfully rich in natural resources, and while only the *Siphonia* or *Hevea braziliensis* has been exploited in the past, there are, in addition to the above, large numbers of the following: *Ficus elastica*, *Castilloa elastica*, *Sapicacœ*, *Morocea* (African rubber vine), *Mimopsys excelsa* (gutta-percha), *Insonandra* (gutta-percha), Vanilla, Copaiba, a species of coca tree, and the quinine tree.

The temperature here is equable, ranging from 70° to 75° F., and in the hotter season it rises to about 85° F., very rarely reaching 90° F. On account of its temperature and healthy climate, the district has been called the Switzerland of Bolivia. It is, in fact, astonishing that rubber will grow in so cool

a climate. The coolness is no doubt due to the close proximity of the snow-clad Cordillera Real.

The old and present system of exploiting the rubber trees in all parts of Bolivia, Peru, and Brazil is very crude and unsatisfactory, but this system was evolved to suit local conditions on account of lack of skill and knowledge possessed by the available Indian labour necessary to carry on the work.

The equipment given each rubber collector consists of a machadine (a small hatchet-like instrument with the cutting edge ½ in. broad), some tichuelas (tin collecting cups made locally), varying from 300 to 1,000, according to the industry and capacity of the picker; a large tin dish, and a tin bucket to hold the latex after collecting it from the trees. Each rubber picker is told off to pick from 150 to 300 rubber trees; this forms an "estrada," according to his capacity, and in the early morning he leaves the barraca (or dwelling), and rapidly, as in the Amazon Valley, runs from tree to tree, striking the bark of each tree with his machadine, with an upward and slanting stroke. This wounding of the tree

causes the latex to flow into the tichuela attached under the wound made by the collector. He will strike each tree with from two to six cuts, placing under each wound a tichuela, and in this way he will continue from tree to tree until the whole of his tichuelas are used up. He then returns to his starting point, and with a bucket gathers the milk that has flowed from the trees along the estrada, until the whole is gathered in. He then takes his bucket or buckets of milk to his barraca or hut to make it up into rubber, and this is his work, day by day, throughout the season. At his barraca he has a humador, *i.e.*, a fire prepared in an earthen oven, the latter having a small orifice at the top for the smoke to escape, and it is in this smoke that the rubber is cured. The collector, or seringueiro, to give him his Amazon name, arrived at his barraca, empties his milk into the tin dish, and warming a piece of wood, shaped like a paddle, with an anchor, the trade mark of the estate, carved on the blade, pours the latex over same, and turns it rapidly in the smoke issuing from the humador. After ten seconds of turning, that coating of latex has become coagulated

Rubber Tapping in Bolivia—Old Style.

and made into rubber, then more latex is poured over the paddle, and the process repeated and continued until the whole of the latex is made up into rubber. This is the crude rubber ball of commerce, known as Mollendo rubber, Rio Beni rubber, and so on.

Practical tests of the various ways of tapping rubber trees in Bolivia, carried on under my personal supervision, have shown that there is an unnecessary waste of the resources of the trees, as well as much damage done to them by careless collectors under the present system. The spiral method of tapping the trees as compared with the old method by means of the machadine shows that the yield of latex and rubber is from four to six to one in favour of the spiral system as against the machadine, or, in other words, a rubber collector working forty Hevea trees carefully every day can produce as much rubber as he could by working 160 to 240 trees on the machadine system of tapping, all things otherwise being equal. The production of rubber from tapping by the spiral system gave astonishing results, especially from new trees. In one case a single tapping in a day from one tree produced 4 oz.

RUBBER TAPPING IN BOLIVIA—NEW STYLE.

of dry rubber. During the experiment the coagulation was made with chemicals and by the ordinary wood-smoking process. Experiments are, and will be, carried on to further test the advantages of the spiral system of tapping on Bolivia uncultivated rubber trees. At present it seems to work out as follows: While it would need 1,000 collectors, with an average of four quintals each, to collect 4,000 quintals of rubber under the machadine system, 300 collectors should be able to easily produce that quantity with the spiral system, and that, too, by only working forty trees daily for a shorter period than they now work 240 trees.

Cost.—The cost of the production of rubber is ever an interesting one in the Amazon Valley. Owing to the peculiar conditions of carrying on the exploitation of rubber in the Amazon basin—which depends on a variety of circumstances, such as transportation, number of tappers employed, price paid per lb. for rubber, all of the above varying from time to time—it is difficult for most owners to arrive at an accurate estimate of cost of producing rubber. After many years' experience in the

LLAMAS FROM THE INTERIOR OF BOLIVIA WITH RUBBER FOR MOLLENDO.

wild rubber and plantation rubber business and the practical working out and exploitation of wild rubber in the Amazon region, I find that the cost per lb. varies on different estates according to efficiency and honesty of management, organization, &c., but I can state without fear of contradiction that localities where the transportation is most difficult, the cost of production, including all overhead charges, freights, insurance, &c., should not exceed 2s. 9d. per lb., in most cases considerably less. Of this amount a large share goes in transport. On a well-organized property, with efficient and honest management, the cost can be considerably decreased. Everything depends on the output, expense of transport, not only of the rubber down to the coast, but also of the machinery and supplies up to the estate, in addition to many other things. A large production could reduce the cost considerably below 2s. per lb., without taking count of the ground crops when cultivated, as is done in the East. Increased and cheaper transport facilities throughout Bolivia, and down to the sea will, when established, greatly improve the prospects of the Republic as a Rubber producer.

THE CULTIVATION OF CEARÁ.

PART I.

KEW[1] summarizes the pros and cons of Ceará as follows :—

(1) The plant is readily propagated both from seeds and cuttings. Seeds are abundantly produced in almost every part of the world where the plant has been introduced. They may be gathered from plants when only three to five years old. Therefore there is the great advantage that a large area could be planted within a comparatively short period. Sowing the seeds in the position where they are to grow permanently is universally adopted in Brazil. It is possible, if adopted elsewhere, this plan would greatly reduce the cost of establishing plantations.

---

[1] Kew: Bulletin of Miscellaneous Information. Selected Papers, Additional Series VII., Rubber, No. 3. Price 1s. 6d. Wyman and Sons, Ltd., Fetter Lane, London, E.C.

(2) The Ceará rubber *plant* is very hardy, a fast grower, free from insect and fungoid attacks, requires little or no attention when once established, and thrives in poor, dry, and rocky soils, unsuited to almost any other crop. It is evident, however, that the yield of a few trees cannot be remunerative, and only large areas can hope to make the industry a paying one.

(3) It produces a good class of rubber, second only, when well prepared, to the best Pará rubber. For this there is a steady and continuous demand. The yield per tree is apparently small, but a return is obtained earlier than from any other rubber plant. With thick planting and judicious thinning, it may be possible as the trees grow up, to increase the yield hitherto recorded, whilst with skilful treatment the permanent trees may be tapped twice yearly, and last in a productive state for fifteen to twenty years.

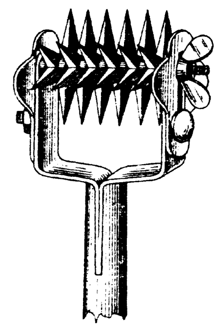
(4) In spite, therefore, of the apparent want of success which so far has attended experiments with Ceará rubber plants in Ceylon and other countries, the increasing importance of rubber as an article in large demand in all

civilized countries at good prices, suggests a reconsideration of the merits of this interesting plant. In many of our Colonies possessing a dry climate and a poor, stony soil, it is possible that large areas could be profitably occupied with Ceará rubber trees so grown as to provide annual crops for tapping.

The name *Manihot Glaziovii*, by the way, is derived from Dr. Glaziou, who sent specimens of this variety to Kew from Paris.

One of the great drawbacks to Ceará in Ceylon and other centres where pricking must be resorted to, in order to extract the latex, has been the absence of a satisfactory multiple pricker. To meet this need I have designed one as per accompanying sketch, which I believe, judging by my conversations with Ceará men at the 1908 Rubber Exhibition, will go some way to help in the matter. The illustration shows a pricker with six rowels, but they can be made to carry as many rowels as desired. In that case extra dummies or washers are provided for screwing in the haft, should it be necessary to reduce, say, a 12-rowel tapper to six only. Regulators are provided, and can be moved up and down

to prevent the prickers penetrating too far into the bark. The block shown was drawn from the first rough hand-made model, and actual tappers for export will be much neater and lighter, but I publish this illustration, being anxious to hear my Ceará friends' opinion



MULTIPLE PRICKING TAPPER, INVENTED BY THE AUTHOR, FOR CEARÁ RUBBER TREES.

—complimentary or otherwise—on the tool before making up a large number, and even those interested in varieties other than Ceará, may be willing to give the implement a trial. If ever punctures are found, as a rule, to be preferable to cuts for obtaining latex, as suggested on pages 323-324, then I believe that

a multiple pricker similar to the one illustrated will be the pattern finally adopted.

PART II.

THE NEW MANIHOTS.

"Wherever conditions are suitable, the cultivation of *M. Glaziovii* will have to be replaced by that of the Maniçobas from Bahia."—DR. ULE.

According to the *Kew Bulletin* (No. 2 of 1908), the German botanists have decided to distinguish the three species of Maniçoba found growing in the States of Bahia and Piauhy by the following designations, viz. :—

The so-called Jequié = *Manihot dichotoma.*

The so-called Sao Francisco Maniçoba = *M. heptaphylla.* The so-called Piauhy Maniçoba = *M. piauhyensis, or piauiensis.*

The seeds of the first are said to germinate very readily, and a sample of so-called Jequié rubber (obtained from *M. dichotoma*) and a sample of so-called Rio Sao Francisco rubber (obtained from *M. heptaphylla*) are both reported to be rubbers of good quality.

M. dichotoma does not form quite so large a tree as Ceará (*M. Glaziovii*), and is from 5 to 12 metres (16 to 39 ft.) in height; the stem

also does not become so thick, and the bark is thinner and usually paler; the smaller leaves, and the large, long seeds, afford the most important characters for distinguishing this species from *M. Glaziovii.*

M. heptaphylla and M. *piauhyensis* are quite different in habit from *M. dichotoma.* *M. heptaphylla* is 3 to 8 metres (10 to 26 ft.) in height, with blackish-brown bark and beautiful purple twigs; the seeds are roundish, as in *M. Glaziovii*, but larger and paler than in that species.

M. piauhyensis is closely allied to *M. heptaphylla*, but forms somewhat smaller trees, from 2 to 5 metres ($6\frac{1}{2}$ to 16 ft.) in height; the seeds can scarcely be distinguished from those of *heptaphylla*, but are rather lighter in colour.

Collection of Rubber.—The mode of collection of rubber from these three specimens differs from that in use for *M. Glaziovii.* The latex begins to coagulate as soon as collected. With careful methods a tree may be tapped from three to ten times. From 10 to 100 grm. of dry rubber may be obtained from a single tapping.

Plantations.—With regard to tapping, *M.*

piauhyensis is ready in the third year, and the other two species may be tapped in their fourth year of growth. The yield of rubber from a single tree of *M. dichotoma* in one year can be reckoned at 100 to 200 grm. with present methods, and this is equivalent to 200 to 300 kgrm. per hectare. The annual yield of rubber for single trees of *M. piauhyensis* and *M. heptaphylla* is from 500 to 1,000 grm., which corresponds, roughly, to about one ton per hectare.

In the plantations, which are laid out in a primitive manner, the seeds are planted in rows 2 metres apart, making 2,500 trees to the hectare (2·47 acres). The advantage of the three species from Bahia and Piauhy is that they are less liable to injury, and that, speaking generally, the yield of rubber is far higher than in *M. Glaziovii*. One hectare planted with *M. Glaziovii* is estimated to yield 300 kilos, whilst 1,000 kilos per hectare is the amount reckoned for *M. piauhyensis* or *M. heptaphylla* when planted in suitable positions. Such a yield exceeds even that of *Hevea braziliensis*, if true, but I have not yet met with confirmatory evidence, and, at the moment popular

favour seems to still be heading towards *M. Glaziovii.* As to the relative values of *M. piauhyensis* and *M. heptaphylla*, the former yields a slightly more valuable rubber, and the tree is ready for tapping somewhat earlier. On the other hand, the latter appears to be a longer-lived tree.

Comparing the Maniçoba plants with Hevea, Ule remarks that there is no doubt that the rubber of *H. braziliensis* is of better quality, possesses greater elasticity, and obtains the higher price; but in spite of this the characteristics of these Manihots make them well worthy of, at least, a trial.

One of the conclusions drawn by Ule from the facts set out is that, wherever conditions are suitable, the cultivation of *M. Glaziovii* will have to be replaced by that of the Maniçobas from Bahia. The question as to which of the three species is to be preferred depends chiefly on the nature of the soil, since they grow under nearly similar climatic conditions.

In a rather firm, loamy soil *M. dichotoma* is said to be the most suitable species, whilst *M. heptaphylla* and *M. piauhyensis* should be planted in a light sandy soil. *M. dichotoma*

has the advantage over the other two species in that its seeds germinate easily.

H. braziliensis is obviously the most important plant for luxuriant tropical regions, whilst *M. heptaphylla* and *M. piauhyensis* must be regarded as suitable rubber plants for dry and less fertile districts.

In planting, the nursery beds may be prepared in the ordinary way for all the varieties. Plant out the seeds about 4 in. apart; and, in dry weather, water to the depth of about ¼ in. twice a day, in the morning and evening. Shading is not necessary. *M. dichotoma* seed begins to germinate in about a fortnight, but the other two varieties take three to four weeks and over. Some of the seeds take over eight weeks to germinate, and great care should be taken to prevent rats, squirrels, &c., from eating the sprouted seeds and seedlings.

PART III.

MANIHOT GLAZIOVII, OR CEARÁ.

Dr. Ule's remarks on the new Maniçoba rubbers tend to make one turn up the literature on the Ceará tree, to see if its future

is doomed, but there is no sign of its being so, for the *M. Glaziovii* has many friends still who show no signs of losing sight of it. Mr. Richard Ott, of Nicaragua, has laid out, I was told, extensive areas in this rubber in Central America. Previous to his departure we had many conversations together on the subject, at each one of which Mr. Ott seemed to emphasize his belief in the *Glaziovii* above all other kinds, so far as his district was concerned.

Mr. Jared Smith evidently also believes in Ceará, as he writes:[1] "The Ceará variety of rubber tree grows in Hawaii better than in its native habitat. The rapidity and vigour of growth on our plantations are remarkable. Many trees show a growth of from 10 ft. to 15 ft. or more during a single season, with girth measurements in proportion. . . . The methods of tapping which this station has developed, and the preliminary experiments already made, indicate that healthy average trees of the Ceará variety, which have attained a trunk diameter of 6 in. to 8 in. at 3 ft. from

[1] "The Ceará Rubber Tree in Hawaii." By Mr. Jared G. Smith and Q. Q. Bradford. *Bulletin* No. 16, issued July 3, 1908. Hawaii Experimental Station.

the ground, will yield from 5 lb. to 10 lb. or more of crude rubber per annum.[1] The Ceará variety seems better adapted to Hawaiian climate, soils, and conditions than any other rubber-producing tree which has as yet been introduced. Its extreme rapidity of growth and its adaptability to widely varying conditions of climate, its large yields and its early maturity, indicate that its cultivation will be the most advantageous." All the same, the natural home of the Ceará tree, according to all accounts, is in the dry regions of Brazil. It takes its best known name from the State of Ceará, as well as its native name of Maniçoba rubber.

Pará rubber appears to have been generally the favourite in Ceylon, although Ceará enthusiasts claim that this kind gives quicker returns and a more ample yield of latex. This preference is due to the fact that at the outset Ceará was planted in unsuitable positions, exposed to the south-west monsoon. Mr. Kelway Bamber, the well-known rubber expert, reports that Ceará naturally "requires a dry climate, and does well on soils of the poorest character chemically," and he has also stated

---

[1] Note the quantity.—H.H.S.

that in North-west Ceylon, which is sheltered from the south-west monsoon by the mountain zone, "two Ceará trees, aged 2 years and 5 months, gave between them a little over 1 lb. of dry rubber of very fair quality, which is far better than Pará can do, even at five or six years, unless heavily tapped."

Some of the old Ceará trees in North-west Ceylon have yielded from 2 lb. to 8 lb. per tree; but this seems to have been exceeded in Hawaii, with its yields of 5 lb. to 10 lb. of crude rubber in the year.

The "Administration Report of the Zanzibar Government" stated that in the Experimental Station of Agriculture where "two species of rubber have been tried—Ceará and Pará—the former was found to produce better results. It appears to possess two advantages over the other species, in that it can be tapped at three years old, as compared with seven or eight years in the case of Pará, and that it can be more easily propagated, the seed being hard and easy of transport, and the plant growing freely from cuttings."

Apparently the good qualities of Ceará are becoming more appreciated in Ceylon, for a

letter published in the *Times of Ceylon*, August 9, 1909, respecting the new rubber, *M. dichotoma*, runs as follows :—

". . . . in growth, at the same age, it certainly does not beat our already established Ceará, and, upon examination of the leaf and branches, certainly never approaches it in free flow of latex. Your readers may rest assured that we have in our midst a rubber—the hitherto despised Ceará—good enough for our wants, a tree better than the Hevea (Pará), and with, moreover, a far freer flow of latex in quality and quantity."

It should not be forgotten that Mr. R. Derry, Commissioner for Malay to the Rubber Exhibition in London, tells you[1] that this rubber, when well prepared, obtains the highest price. It was the novelty of the Lanadron block rather than intrinsic quality that obtained for it the gold medal over a sample of Ceará rubber. It grows best in dry, tropical countries on the poorest soils,[2] and if

[1] *Agricultural Bulletin of the Straits and Federated Malay States*, February, 1909.

[2] This does not say that the tree cannot and does not respond to nourishment and moisture.

carefully cultivated, must be reckoned with as a rubber of the finest grade. Analysis shows:—

Caoutchouc	...	82·8 to 85·6 per cent.
Resin	...	5·5 ,, 6·3 ,,
Proteids ...	...	6·2 ,, 9·4 ,,

Ceará Biscuit, mark "North Matale," sold at 9s. 1d. per lb. on September 28, 1909. This shows that, at least as regards quality, the rubber, if properly prepared, leaves nothing to be desired.

On the page opposite we have a good example of a well-developed but badly grown Ceará tree, which has been allowed to fork out instead of growing on to a single trunk. This reduces the tapping area, and spoils the tree as a latex producer.

The possibilities of Ceará rubber as a sound investment in the Bahamas are generally recognized,[1] and many farmers are planting it, one estate having already planted fully 50,000 seeds, and 60,000 more have been sent over to the Islands. During 1907 the Bahamas apparently imported about 200,000 seeds.

[1] *Bulletin of the Agricultural Department*, Bahamas, March and April, 1908. Edited by the Curator, Mr. W. Munro Cunningham.

The trees planted in the Botanic Station were doing well. One, Mr. Cunningham

CEARÁ RUBBER TREE, THREE YEARS OLD, IN SAN THOMÉ.

reports, that was imported from Jamaica, and planted on June 16, 1906, is 11½ ft. high, and

trees planted on June 24, 1907, from Ceylon seed, were 5 ft. high on January 23, 1908. In Hawaii, 400,000 rubber trees are returned as having been planted, and of these upwards of 360,000 (over 90 per cent.) were *Manihot Glaziovii*.

According to the *Hawaii Bulletin*, the Ceará tree is a rapid grower, with a loose spreading and not very leafy top. It usually branches in threes, and these again branch in turn, and so on during the life of the tree. When growing in the open in Hawaii, under favourable conditions, as with the Koloa group (planted about 1894), the trunks of the fourteen-year-old trees average about 44 in. in circumference at 3 ft. from the ground. The wood is soft and spongy and white. The growth rings are not prominent.

The roots are shallow and not very numerous.[1] They are thick and fleshy, and bear elongated fleshy tubers, very much resembling the roots of the cassava and sweet potato. At the London Rubber Exhibition the Ceylon Court had a young tree with tubers attached, the bark of

---

[1] *Bulletin* No. 16 of the Hawaii Experimental Station.

the trunk showing the well-known resemblance to the silver birch. The tree regularly sheds its bark, the outer layer of which is tough and papery. As the new growth of bark forms immediately outside of the cambium layer, the outer bark dries and sloughs or peels off continuously. In the roots the young tubers have a very thin bark, and contain a large percentage of starch. As the tubers grow older the bark thickens, the outer surface becomes woody, and the centre is filled with pith and water.

One Bahia writer claims that the Maniçoba does better in a clay soil lightly mixed with sand. The same writer confirms the opinion that, whilst the tree can withstand extreme drought, it also takes kindly to well-irrigated land. Increased moisture must, and undoubtedly does, encourage the latex flow. Moist air surrounding the tree encourages quicker growth.

One drawback with the Ceará tree seems to be its liability to be broken by the wind. The newly-named species, *M. dichotoma*, &c., do not seem so liable to be thrown down, but then they evidently do not grow to be so tall as the *Glaziovii*. A Brazilian insect (the cupim) attacks the wood as it does white pine. The

Maniçoba (*Glaziovii*) tree attains a height of 30 ft. according to the *Bahia Boletim*, but as others speak of its branching at 25 ft. the total height would, in such a case, probably be at least another 10 ft. to 15 ft. The trunk of the largest tree in the Koloa group—Hawaii—at fourteen years old, measured 47 in. at 3 ft. from the ground. Gigantic trees (the *Bahia Boletim* describes them) cannot resist the undermining of the cupim for more than one year. When the first high wind comes they fall, throwing shoots sometimes to the ground, which take root and form new growths. This, however, must, if possible, be guarded against on cultivated lands, because, even with less brittle trees, the fall of one of the giants always does much damage to its neighbours. Even a large branch breaking away leaves a most undesirable gap at times. Cattle are said to like the young Maniçobas to eat, so that care must be taken to keep them away.

Reports and opinions vary considerably as to the yield obtainable from *Glaziovii*, or as to the age when the tree can be tapped. If those who claim that several pounds per annum are obtainable from Ceará trees are correct, it

would look as though circumstances favoured some estates more than others.[1] In such cases those who obtain the smaller and more general yields would be well advised to study the advantages enjoyed by their fellow-planters, and see whether some of these advantages—as increased water supply, or a moister atmosphere, better soil, &c.—cannot be obtained on their own estates.

With regard to the age at which one can start to systematically tap the trees, the general idea seems to be that this can be done from three to five years old. "No two trees are alike," Jared Smith tells you.[2] "For this reason every tree in the plantation should be tested before it is two years old to determine whether it yields a paying quantity of latex. There is no need for waiting four or five years to cut out unproductive trees. The widest variation exists both in the proportion of rubber contained in the latex and in the amount and

[1] The above bulletin, I see, speaks on p. 29 of yields of 5 lb. to 10 lb. of crude rubber per tree each year.

Bulletin No. 16 of the Hawaii Experimental Station already referred to.

freedom of flow of the latex itself. The outward appearance of the tree is no indication of its value as a rubber-producer. The latex of some trees is thin and watery. The older the tree the thicker the latex, but there is great difference even among young trees. Trees yielding thin, watery latex without any appreciable amount of rubber should be cut out and destroyed and their places filled with cuttings taken from trees yielding large quantities of rubber."

Mr. Fawcett, in his translated extracts[1] from the *Boletim de Agricultura*, Bahia, states that whilst the Maniçoba has a rapid growth, principally at the commencement of its development, it is believed that from the fourth to the fifth year it can produce, but the maximum of production is from the eighth year and onwards, as with cacao. That cultivated Ceará when in congenial surroundings can give good rubber-yielding latex at three to five years has now been confirmed by reliable authorities, and the same bulletin claims that the Maniçoba, the

[1] *Bulletin of the Department of Agriculture*, Jamaica, February and March, 1908.

same as the Hevea, increases its yield after repeated tappings, but does not say up to what age the tree will continue to give latex in commercial quantities. Maniçoba, we are told, is educated in its milk production, in the same way as the breasts of animals are habituated to give the maximum production of milk. In the course of some experiments an increase in the milk yield after repeated tappings was observed. The fact is known to all Maniçoba rubber collectors.

The same authority mentions that Ceará seeds constitute a food liked by cattle, and of great alimentary power from the richness of fat material. They can be ground to produce a rich forage, superior, perhaps, to the flour of the seeds of cotton and other similar seeds.

The Question of Tapping.

At the Rubber Exhibition held in London in 1908 the best method for tapping Ceará rubber trees was freely discussed. There is no doubt, at least there seemed to be none at at that time, that a perfect Ceará tapper has still to be invented, and I propose using six or more spurs or prickers in a row, like the block, shown on page 420, taken from a sample

made according to my design. This tapper, as has been described, is supplied with a regulator to prevent the spikes going in too deep, and in

[*By courtesy of Sir Guildford Molesworth, K.C.I.E.*]
CEARÁ RUBBER TREE.
Tapped on the Spiral System.

theory it meets all the requirements of those who have made any suggestions on the matter.

In some centres, however, paring knives, like the Bowman-Northway, can well be used.

as both in Hawaii and Nyasaland the herring-bone system of tapping Ceará has given quite favourable results.

Whatever system is employed the entire outer bark, which is tough and papery, must be removed, and the younger bark left smooth and clean. In Hawaii it has been found that the average Ceará tree stops its flow of latex by complete coagulation within from two to five minutes when water is not used.

In *Bulletin* No. 16 of the Hawaii Agricultural Experiment Station, issued in July, 1908, important particulars are given of tapping experiments undertaken on old trees. In one instance the age is given—viz., nine years. The conclusions arrived at show that there seems to be some relation between atmospheric conditions and the flow of latex, but it has still to be determined what this relation is.

The best time to tap is at night or during the early morning. The flow of latex is said to be highest between midnight and 7 or 8 a.m. In Hawaii they found those trees that were tapped either just before the resting period, or at the time they were bare of leaves, did not leaf out as quickly as others near at hand which

had not been tapped. It was, according to Mr. Wilcox, difficult to coagulate the latex at

[*By courtesy of Messrs. Molesworth Bros., Ceylon.*]
OLD CEARÁ RUBBER TREE IN CEYLON.
Note the clean stripped area ready for tapping.

times. Both at Kanai and Oahu double the amount of rubber, generally speaking, was

procurable by trickling water containing ammonia over the tapping area, than when no water was used. At Koloa some trees planted about 1894 were tapped in 1907-8. Two of them were then 44 in. in circumference at 3 ft. from the ground, and both branched at 6 ft. These two trees, although they were terribly scored by promiscuous tappings (?) or rather hackings, still yielded 18 oz. of washed rubber in nine days' tapping, and it was then considered that had vertical incisions been used instead of the herring-bone system, a very much larger yield of rubber would have been obtained. As it was, a good deal of the latex was wasted on account of the inequalities of the bark. Generally speaking, the Hawaii experiments on these old trees caused those who were carrying them out to consider that daily tappings for a period of two or four weeks or more would yield much better results than tappings on alternate days, or at longer intervals over a period of several months. Daily tappings it was found, for a period of nine days, gave better results than tapping on alternate days for double the time, and the recovery of the tree was more rapid. Young

trees were not so readily injured by too deep cutting as older trees. In young trees the wounds, it was found, healed very rapidly.

The explanation as to why the flow of latex is very much heavier and more rapid during the night, is to be found in the fact that during the hours of darkness there is an almost complete cessation of evaporation from the leaves, but the roots still continue to take up water from the soil, and this results in greater tension of the sap and the latex in the tree. The latex of young trees coagulates more slowly than that of old ones. In Hawaii, when vertical cuts were used, a canvas bag was tied round the tree above the cuts. The bag went half round the tree, and was sewn up in two places, as well as at the ends. Three compartments were thus formed, one for each vertical cut that ran down from the centre of each compartment. The water is conducted to the cut by means of a piece of porous cloth sewn up the centre of each compartment of the bag, which otherwise would not have leaked, or would have done so in the wrong place. This porous or water-conducting cloth protrudes evidently through the bottom, and so,

although sewn in, the water at these places can ooze through and down the vertical cuts. The bag is left on the tree during the whole tapping season. About a pint of water is put in each bag (whether the whole bag or each compartment is not quite clear), and about $\frac{1}{2}$ oz. of ammonia per gallon of water is added. Younger trees need rather less ammonia, for their latex, as already stated, coagulates more slowly. Whether herring-bone or vertical cuts are best remains to be seen. In Java, one man claims that the vertical cuts are best, but several planters and journals speak of the herring-bone method. There seems no doubt, however, that the Ceará is unreliable in its yield, and that on this account young estates must be watched and tested as soon as possible, and those that show signs of not being good tappers must be replaced by others; Jared Smith recommends doing this by means of cuttings from trees known to be good. It would be interesting to examine the trees removed on account of being poor tappers, in order to see if their roots, or tubers, or any portions of them, are poorly developed or over abundant, so as to account for the poor latex yield of the tree.

It may be remembered that about January, 1908, the *Times of Ceylon* mentioned a report of the *M. dichotoma* in Brazil yielding a ton of rubber per acre. As that cautious but ever polite journal added, this sounds much too good to be true. It quotes Dr. Ule's description of the Brazilian method of tapping the *Dichotoma* in its native wood. The stronger trees, we are told, are tapped with a sinuous or wavy cut, by a knife which is either bent at the point or truncated. Sometimes a straight cut is used with or without lateral cuts. The latex cup is attached to the bark to catch the milk. If tapped carefully the wound heals after a time, and the tree can be tapped again and again, from three to ten times. I suppose this means during the tapping season, which, as a rule, is not for the whole year.

Dr. Ule considers that, both with *M. heptaphylla* and *M. piauhyensis*, the best method for tapping was to scratch the trees just above the root, removing the earth from below, and catching the latex as it comes out. The native allows it to go on the ground or into a clay receptacle, but that dirties it. The shorter stem and thinner bark seems to render this

By courtesy of the East African Estates, Ltd.

A FINE CEARÁ RUBBER TREE IN BRITISH EAST AFRICA.

method better than to cut the trunk. Regarding the best soil for the three new Manihots, Dr. Ule considers that for good stiff loam or for heavy clay *M. dichotoma* is best, whilst the others are more suitable for light sandy soil.

As to yields, Mr. Bertram Davis, of Malindi, British East Africa, reported on June 17, 1910, in the *Nairobi Leader*, that five men brought in 27 lb. of wet rubber in five days from 3,409 trees. This equalled 1·08 lb. of wet rubber per man per day, or 0·12 oz. per tree. "Taking only, say, forty tappings, this will equal 4·80 oz. of wet rubber per tree, or 2·40 oz. of clean, dry sheet or crêpe." Mr. Davis goes on to explain: "The amount of acetic acid used, 3 oz. per man per day, equals 15 oz. in five days; allowing, say, 16 oz., this would equal 1 lb. of acid per man, or 5 lb. of acid for 27 lb. of rubber, or say half a gallon of acid costing Rs. 4.8 or 17 cents per lb. of rubber. Taking the men's wages at 44 cents, I am able to collect rubber for 61 cents per lb. Of some special trees I am tapping separately. (I call them manured trees, as they are growing in the middle of the labour lines.) No. 1 gives 3 oz. of wet rubber per tapping; No. 2,

CEARÁ RUBBER AND SISAL BELONGING TO THE EAST AFRICAN ESTATES, LTD., BRITISH EAST AFRICA.

2 oz.; No. 3, 3 oz.; No. 4, 1 oz.; another group of eighteen trees in the same village, all three years old, yields 1 lb. of rubber per tapping. It takes from 120 to 130 ordinary trees in the shamba to give this result, taking a man about six hours to collect it, the group in the village taking a man about one hour. There is no doubt in my mind now that with selected seed, intense culture, and manuring, small acreages will give larger profits either for private individuals or companies growing Ceará rubber."

It is anticipated that with the most suitable type of knives it will be possible to tap the trees every alternate day throughout the year, viz., 156 working days; and—taking the past 86 working days as a basis for calculations—100 trees, tapped every alternate day for 86 days give a daily average of 18·49 oz. wet rubber. Therefore 100 trees, tapped every alternate day for 1 year of 165 days, give in the year 2,884·44 oz. wet rubber, 2,884·44 oz. wet rubber for 100 trees = 28·84 for one tree. If the land, therefore is planted up with 1,000 trees to the acre ($6\frac{1}{2}$ by $6\frac{1}{2}$), which is about the most suitable number, this means that

one acre of land should, when the trees average the same girth as those now being tapped, yield 1,803 lb. wet rubber or say $901\frac{1}{2}$ lb. dry rubber, value at 2s. 6d. per lb. equals £112 13s. 9d.

Here at least, therefore, we have particulars of actual yield from Ceará trees, how they were obtained and what they cost.

Mr. Stewart McCall, the Director of Agriculture in Nyasaland, issued an official circular on the benefits conferred on Ceará yields by green manuring, as it increases the amount of water in the roots, by preventing evaporation during the day. To those who favour wide planting, green manuring would prove a double blessing, as it can keep down the weeds, and benefit the yield. Green manuring, the same as weeds, also keeps the humus *in situ*. Without it an immense amount of top soil and humus is washed from where it is badly needed to a spot where probably it is no use. The late Mr. Carruthers, in what I believe was the last report he issued before relinquishing his Eastern post, gives some useful advice as to which cover-crops should be used, and how care must be taken in planting the seed, so

that the roots of the trees be properly covered. To ensure this the crctalaria, or other seed, should be dibbled in, not sown broadcast.[1] Cover crops must be kept low, under 3 feet at the most in height. The cutting, Mr. Carruthers tells you, is not a costly process, as it is only necessary to slash the tops, and leave the cut parts there as a mulch. Creepers, like the passion flower (*Passiflora fœtida*), must be kept from twining round young rubber plants.

Discussing the question of tapping Ceará trees in East Africa with one of the chief men attached to the African Lakes Corporation, Ltd., he told me, as stated elsewhere, that they found the herring-bone system quite satisfactory, and that the latex ran all right, especially if drip-tins were used. The "Handbook of Nyasaland" gives fuller particulars. From this it seems that the tapping experiments, commenced in 1906, are still being continued. These led the managers to consider that, of the several systems tried, the "full herring-bone" was the best, and it has therefore been

---

[1] These particulars are reproduced in full in the *Trop. Agric.* of September, 1909, pp. 274-5

adopted for trees measuring between 25 in. and 35 in. in circumference 3 ft. from the ground. The Bowman-Northway No. 2 Knife was used. Probably now their Simplex Knife has taken its place, as being particularly suitable for Ceará bark, both for making the first cut as well as for paring the edges in subsequent tappings.

The method employed was, as usual, to strip off the thin outer covering of bark, and then to leave the trees untouched for a week or ten days. Doing so allows the tissues to recover from the exposure to the atmosphere, and another thin crust to be formed over the surface. A vertical groove is then made from the height of the tapper's reach to within a few inches of the ground-level; in making this cut the knife should be held slightly on one side so as to slope the edge inwards under the bark, to prevent any chance of the latex over-running the sides. Great care is necessary, both in cutting the original grooves, as well as when subsequently paring the lower edge of the grooves, not to cut through the cambium and expose the wood. The cambium, unlike the cortex, does not recover after being incised,

but produces a knot in the wood, and the tree, if badly incised, can be killed.

After making this vertical groove, a small tin spout is inserted at the lower end over the

[*By courtesy of the "Mindanao Herald."*]

CEARÁ TREE IN HAWAII.

Tapped on full herring-bone System.

vessel placed there to receive the latex exuding from this central cut. Now to make the side cuts. These, I strongly recommend, shall

be made alternately, not equal as in the Hawaii block, otherwise there is a tendency to ring the tree, especially when of small girth, without any counteracting advantages. With the African lakes experiments the half-herring-bone system was found sufficient with trees from 18 in. to 20 in. in circumference, *i.e.*, 6 in. to 7 in. in diameter. The full herring-bone system was not recommended for trees under 12 in. in diameter. In this case the drip-tins were not fixed in the tree. Two smart lads were told off with each tapper to collect the latex and arrange the drip-tins, which are held by the boy, and shifted from groove to groove if the latex runs too slowly or ceases to flow. As the latex coagulates very quickly, especially if in small quantities, the collected latex is mixed with plenty of water, and poured into the general receptacle as soon as possible. If put into bowls, the biscuit is quickly formed, and can be taken out, and the water expressed the same day.

A table of statistics was given[1] showing that

[1] Thsse and other particulars *re* Ceará can also be found in the Ceylon *Tropical Agriculturist*, July, 1909, p. 81.

eighteen Ceará trees tapped sixty-two times between November 21, 1906, and September 6, 1907, yielded, in these nine and a half months, 1 lb. $1\frac{1}{2}$ oz. of wet rubber; equal approximately to $8\frac{1}{2}$ or 9 oz. of dry rubber, *i.e.*, just one half. We are not told the age of the trees, but that it would probably take the other trees six years to attain the size reached by those which were tapped.

The following particulars show the results obtained from one batch of trees after following the foregoing system. These trees were tapped about every other day for one month, making twelve or thirteen tappings for the month, then allowed to rest a month, and tapped again the following month, and so on until the trees had undergone either a complete cortical stripping, or only half, as desired. It is estimated that $\frac{1}{10}$ or $\frac{1}{12}$ in. is all that should be removed of the cortex in one tapping after the grooves have once been opened. If this rule is followed, it will take two years to entirely strip a tree, after which time operations could probably be continued on the new bark. After nearly two years' experiments the trees are showing no ill

effects through excessive tapping except where the cambium has been inadvertently incised. It may be added that the Ceará trees on this estate are of various ages, and had received practically no attention before these tapping experiments were commenced. Many of them had been damaged by bush fires, &c.

The *cost* of collecting Ceará rubber in the manner above described is shown by these figures compiled from the latest five months' results (to September, 1908) on this estate. One native tapper, with an assistant, taps 50 trees per day, the average quantity of wet rubber obtained daily, taking the average for 86 working days, being 9·24 oz., yielding 4·62 oz. of dry rubber. The cost of collecting and preparing the rubber works out at 1s. 2½d. per lb., excluding cost of European supervision.

Quoting Mr. Ridley at the Straits:—

"In Southern India, experiments were made with the tapping of Ceará rubber by the use of a pricker. Ceará rubber trees are always troublesome to tap, and the idea was to simplify the business by pricking. It was found, however, that the pricking, if carried to

such excess that a good flow of latex was obtained, was often fatal to the tree from the injury to the bark. We have no information as to the new invention referred to below, beyond what we give our readers, but realizing that close puncturing of the bark of a rubber tree is apt to make a sore, and cause the death of a tree, one would be a little cautious in this form of tapping. One of the advantages pointed out in the process is that three-year-old trees can be tapped by it. But is this an advantage? While the price of rubber of any kind keeps up as it is doing now, one cannot wonder even if seedlings are tapped, but this is by no means good for the trees or for the industry.

"Recently a planter in Ceylon invented a new process for extracting the latex from rubber trees. Instead of employing a knife, or of making V-shaped or spiral incisions into the bark, he employs a pointed instrument which pricks the tree without doing it much harm. The new system produces a larger quantity of latex, and has the advantage that it can be used on young trees of three years old. It is interesting to learn that a Colombo

firm have undertaken the working of the invention and offered to teach its use to planters for a fee of 500 rupees, the fee to be returnable in case of failure. A large number of planters have already availed themselves of the offer, and it is thought that the production of rubber in Ceylon will this year exceed all expectations. Apparently, it is too early yet to pass any definite judgment on the new process. The advantages claimed for it are simplicity, economy of labour and cost of production, that it causes less harm to the trees and ensures larger and quicker profits. But on the other hand, it remains to be seen whether the sap of the young trees mentioned will produce as good a rubber of equal elasticity and resilience as that of the older trees which have arrived at maturity, and whether ultimate injury will not have been caused to these young trees.[1]

At the Government Gardens, in Kuala

---

[1] The *Straits Bulletin* for July, 1910, contains two very important articles, viz.;—

(1) Experimental tapping of Pará rubber trees in the Botanic Gardens, Singapore, for the year 1909.

(2) Notes on the cultivation of *Hevea brasiliensis* and

Kangsar, average yields of about 9 lb. per tree, up to 12 lb. for some of the oldest, is reported. Some of these "old" trees have been planted since 1877, so are over thirty years old.[1]

In the *Agricultural Journal of British East Africa*, April, 1908, Mr. H. Powel writes freely on Ceará. He discussed propagation by cuttings, the rubber from which, he tells us, is said to be of the same quality as that obtained from seedling trees. As regards the difference, if any, in yield he has no particulars. The cuttings are sections of the branches an inch or more in diameter, and a foot or upwards in length. These grow

yields, with an exhaustive table on close-planting and the increment of growth.

In this article the various methods of tapping are touched upon, and the returns per tree at various ages, &c., given. Unfortunately I cannot do more than refer to them here. Elsewhere we are told that the Manager of the Bukit Rajah Estate found that the best results have been obtained from trees planted 27 ft. by 27 ft. It was found that in crowded fields the bark does not renew so thickly, and that the trees do not yield so much latex. Trees at the Sungei Biujai, planted wide, yielded 4 lb. per tree, or 300 lb. to the acre.

[1] *Straits Bulletin*, January, 1910.

readily, but the trees are liable to assume a dwarfed, straggling habit, and give off several stems which, if not removed at an early stage, retard the development of the tree.

Discussing yields of Ceará trees in German East Africa, Mr. Powel, quoting an extensive grower, gives the following :—

2nd to 3rd year, $\frac{1}{5}$ lb.	per tree	per annum.
3rd to 4th year, $\frac{1}{4}$ lb.	,,	,,
4th to 5th year, $\frac{1}{2}$ lb.	,,	,,
5th to 6th year, $\frac{3}{4}$ lb.	,,	,,

The last quantity ($\frac{3}{4}$ to 1 lb.), according to this authority, is all you can look for as an average return even when the tree is in full yield, although, of course, individual trees frequently give much larger returns. Some 9 to 10 year-old trees on the Lewa estate, for instance, are said to have given 10 to 14 lb. each in the year, but then, Mr. Powel adds a serious fact, if true, viz., "as a rule trees of 10 years old are said to cease yielding rubber in paying quantities."

According to the *Uganda Official Gazette* of June 15, the following method of tapping Ceará trees was used at Entebbe, on a Ceará

Rubber Estate belonging to Mr. Allidina Visram.[1]

"On the 16th of April last I took the girth measurements of 20 trees at a height of 3 ft.; the average girth of these trees was 19 in., the largest being 26 in. and the smallest 16 in. On the same date I tapped these on the 'half-herring-bone' system.

"Tapping was done to a height of 3½ ft., and from the system adopted it will be seen that only half of each tree was tapped. The trees are approximately 2 years and 9 months old.

"The trees were tapped every alternate evening between the hours of 5 and 6.30 p.m., for a period of one month. Each tree was tapped 15 times. The flow of latex was encouraged by paring and pricking, and wound response was excellent throughout the experiment.

"The quantity of dry rubber obtained is 2 lb. 5½ oz., of which 1 lb. 14½ oz. is biscuit rubber, the remainder being composed of the

---

[1] See also *Zanzibar Gazette*, July 15, 1910, and *Trop. Agric.*, Ceylon, September, 1910.

latex which coagulated in the cuts and was collected as scrap rubber. The above represents an average yield of 1 oz. 14 dr. per tree for the period, and allowing that tapping could be done in 180 days per year, this would represent an annual yield of 1 lb. 6½ oz. per tree, which is exceedingly good, especially considering the youth of the trees and the fact that they have been tapped to a height of 3½ ft., and that only one half of the tree was tapped. A very weak solution of formaline was added as a preservative, and the latex was coagulated in enamel plates by adding a weak solution of acetic acid."

The *Planter's Chronicle*, Bangalore, for March, 1910, gives the following results of Ceará-tapping in Mysore, at an altitude of 3,300 ft., with an average rainfall of 90 to 100 in., but frequently with no rain from October 1, until April.

DRY RUBBER.

(1) Ten of the best-grown trees in a 5-acre clearing 3½ years old, with an average girth of 13 in., 3 ft. from the ground, tapped alternate days in October and December, 1909, and

February, 1910 (*i.e.*, with a month's rest between) = 44 tappings per tree, or 440 tappings, gave a total of 4½ lb.

(2) Five trees of average girth 17 in., in a 5-year-old clearing, tapped as above, gave a total of 5 lb.

(3) Five trees, 10 years old, girth 26 in., tapped as above, gave 7 lb.

(4) Two trees, 10 years old, girth 32 in., tapped as above, gave—No. 1, 2¼ lb.; No. 2, 2¼ lb.

(5) One tree, 15 years old, girth 43 in., tapped as above, gave 4 lb.

These yields, it is argued, are equivalent to:—

(1)	100 lb. per acre	Of 200 trees tapped on alternate days and during alternate months.
(2)	400 lb.	,,	
(3)	720 lb.	,,	
(4)	875 lb.	,,	
(5)	1,600 lb.	,,	

The trees appeared to have suffered no harm from the tapping.

In the annual report for the Nyasaland Protectorate to March 31, 1910, Mr. McCall, the Director of Agriculture, gives on page 8 full details of the results of experimental tappings

of four-year-old Ceará trees, carried out on the Michiru Mountain Rubber Estate, situated near Blantyre, in the Shiré Highlands. A table of the results is given for each day on which the tapping was carried on, and this shows that twenty tappings carried out by 42 tappers at twopence per day, and 22 tappers (children) at one penny a day (per day, not per hour), cost altogether 8s. 10d., and gave $597\frac{3}{4}$ oz. wet rubber, or 398 oz. dry rubber. These 398 oz., or 25 lb. (less 2 oz.), of dry rubber therefore cost about 4d. per lb. to collect. The rubber was made into biscuits, and passed through a wringer, and then otherwise dried. The trees were planted 15 by 9, and 12 by 9, and varied between 12 and 19 in. at girth at 3 ft. from the ground.

Part IV.

Seeds and Planting.

These two items are fully dealt with in the excellent *Bulletin* No. 16, issued by the Hawaii Agricultural Experimental Station, under the care of Mr. Jared Smith. The *Jamaica Bulletin* (edited at that time by Mr. Fawcett) for January to March, Parts I. to

III., also contains important information on the subject, including a translation by Mr. D. A. Wetherall of a treatise on the Ceará tree from the *Bulletin of the Department of Agriculture*, Bahia, Brazil, for August, 1902.

Señor Augusto Cardoso, who writes in Spanish, published a series of articles in *La Hacienda*, of Buffalo. This authority tells you that the Maniçoba tree should be planted in such a way as to be shaded as much as possible, as that encourages its growth. The wind, Cardoso tells you, is the worst enemy of the Maniçoba, as it can easily break it, or at least blow it down. Cold winds are, above all, prejudicial even when not strong, as they dry the leaves rapidly. The latex, we are told,[1] occurs in the leaves and leaf petioles, as well as in the bark of the twigs, trunk, and roots; in fact, there is a continuous network of milk tubes all through the living green portion of the bark of the trees. The wood alone contains no latex, although there are latex tubes in the pith. This being so, it is easy to realize that, whatever affects the leaves of the

[1] *Hawaii Bulletin*, No. 16.

tree would, since the network of the tubes is continuous, more or less affect the whole tree.[1] The tubes themselves are not continuous—that is, by cutting through the tubes at the base of the tree you cannot drain the tree of its latex, but in the living plant there is a free transfer of the latex from one tube to another. The latex-bearing tissues may rather be compared to a series of short tubes joined end to end with permeable diaphragms between.

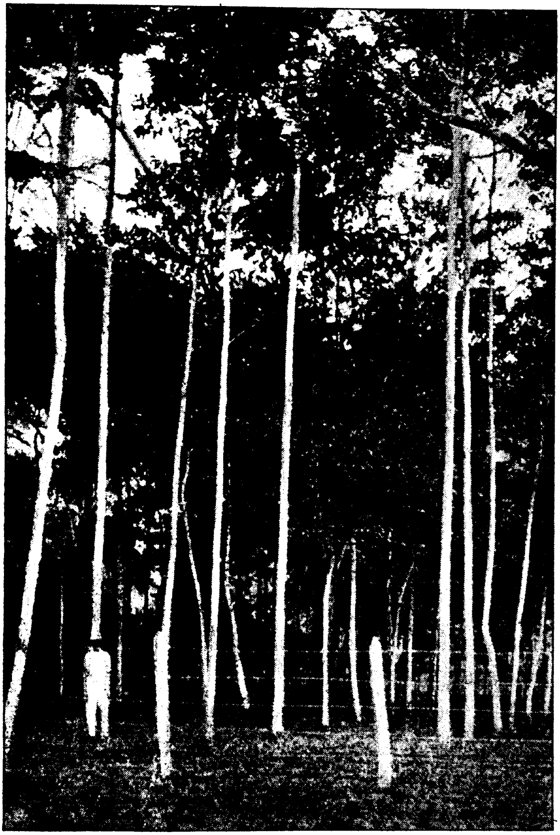
This necessity of protecting the trees from strong winds for fear of breaking, or from drying winds on account of their adverse effect on the leaves, tends to make one plant as closely as possible, so as to enable the trees to help to protect each other from the wind. Another advantage in close planting is that it keeps down the weeds, which seems necessary. As, however, no well-conducted, cultivated estate should have young plants out in the open, but should rear them in the nursery or

[1] The Commission appointed by the Bahia Government to study the Maniçoba cultivation report that the milk appears in abundance at the branches and roots. They also encountered latex in the pith. Does this refer to the pith of the roots, which, as the tree ages, becomes filled with pith saturated with water?

in bamboos like cacao, this should not be a main reason for close planting. It seems that ants are very partial to the seedlings, and cause much mischief; so do rats and mice. To avoid these and other pests, it is all the more necessary to start with a nursery, which can at least be planted away from such plagues, with an isolating clearance around it. If they appear, steps must then be at once taken to trace them to their source in order, if possible, to exterminate them.

Cardoso, in *La Hacienda*, gives some useful hints with regard to choosing the spot for a Ceará nursery and laying it out: "The ground," he tells you, "must be sheltered from the winds, and should be near water, so as to enable you to water both the seed-beds and the nursery.[1] The seeds will be sown *à granel* (in bulk or close together), and covered with a thin coating of earth. The nurseries should be worked a month or two before the rainy season sets in, and should always be kept

[1] The Spanish word is *vivero*, as can be seen a line or two further down. Señor Cardoso recommends transplanting twice—the first time at fifteen days old into the *vivero*, and then about a year later into the full estate.



Reproduced from the Trinidad W.I., Bulletin.]

FUNTUMIA ELASTICA AT EXPERIMENT STATION, TRINIDAD.

Compare the trunks with the man's height and their girth with his shoulders. These trees, I consider, are, the same as those on p. 376, also much too tall, and show too small a tapping area, compared to their height.

abundantly watered. When fifteen days old, the plants should be taken from the seed-bed and transplanted into the *vivero*, where they will remain for a year at least, and should still be kept well watered in case of a failure in the rainfall. Even after the rainy season has ended the watering should be continued for a month or two. This irrigation gives the plant a long period of continuous growth from its start, and thus provides for the rapid formation of trees of large dimensions in the future.[1] At the end of a year the final planting-out can be started. The trees should be placed in a perfectly upright position in holes 1 m. (39 in.) cube, more or less, and surrounded with organic refuse and earth."

The *Hawaii Bulletin* says that the holes should be at least 2 ft. across, and as deep as possible. This authority does not say at what age to undertake the final planting, but that in Hawaii it is best done in the spring (January to March), following the rule that those

[1] There is a tendency for tuberous roots to become mildewy and rot in continuously sodden ground; the planter must therefore see that there is a sufficient amount of drainage to avoid this.

seedlings which receive the benefits of hot, growing weather make a better and more healthy growth than those planted at the end of the growing season. A good time to transplant, they add, is in the evening or late in the afternoon, or on cloudy days, so that the plant may become accustomed to its new location without excessive welting.

According to the *Bahia Boletim*, quoting Señor Delpeche, plants a month old were 15 cm. (6 in.). Another planter (H. Lember) recommends planting the seeds in an open bed, about 3 in. apart, covering them with about ½ in. of soil, and water twice a day if no rain falls. The bed should be well exposed to the sun, as shade spoils the seed. They can be transplanted when 1 ft. high.

Many suggestions have been offered for hastening the germination of the Ceará (*M. Glaziovii*) seed. Olsson-Seffer offers the following one :—

Place a layer of fresh horse-manure in a box to the thickness of about 6 in., spread the seeds on the surface and cover with about 1 in. of the same material mixed with a small quantity of sand. The soil

should be slightly packed and the box covered with glass. If put in a warm place or in the sun, germination will then take place very quickly. The seedlings should be planted as soon as they are an inch or two high, and some manure must be added to the soil. After such treatment the seedlings will grow very rapidly. The soil should be well weathered, and if too sour, some lime added *before planting.*

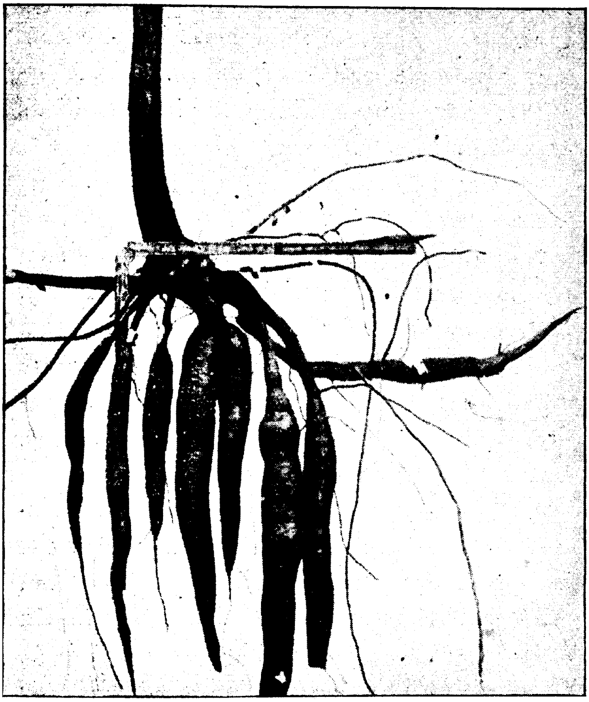
The Curator of the Rhodes Matopo Park (S. Rhodesia) reported that he obtained very successful germination from Ceará rubber seeds soaked in water for three weeks before sowing, instead of adopting the old method of filing the seeds.

PART V.

MISCELLANEA.

IT is stated by our painstaking Consul at Bahia, Mr. O'Sullivan Beare, that the planters of Bahia have paid much more attention of lâte to the *M. dichotoma*, and the Agricultural Department also hopes to cause special attention to be devoted to a more systematic cultivation of this rubber. If they do not do so it

seems as if supplies from that centre will soon be exhausted and cease altogether.



[From the *Hawaii Bulletin*.]

TUBEROUS ROOTS OF A SIX-MONTHS-OLD CEARÁ RUBBER TREE.

Going back to the Ceará variety (*M. Glaziovii*), the Hawaii station considers that this

kind seems better adapted to Hawaiian climate, soils, and conditions than any other rubber-producing tree which had been introduced up to then (1907-08), for these reasons :—

(1) Extreme rapidity of growth.

(2) Adaptability to widely-varying conditions of soil and climate.

(3) Large yields.

(4) Early maturity.

Speaking of the *Glaziovii*, in his report on the London Rubber Exhibition, Mr. Derry, the Commissioner for Malaya, reminded us that Ceará rubber when well prepared is capable of obtaining the highest price. This was confirmed in London, when, in September, 1909, Ceará biscuit realized 9s. 1d. per lb.[1]

In Ceylon the finest Ceará trees are Trincomalee way, on the north-east side of the island. This district from all accounts is not receiving the attention it deserves. It ought to be able to do better with Manihot rubbers, Ceará or otherwise. According to Mr. Geoffrey Williams in the *Agricultural Journal of British East Africa*, samples of Ceará sent home for

---

[1] *Tropical Life*, October, 1909, p. 169.

report and valuation from Africa were valued at least as being equal to the best Pará. On the Kibwezi Plantations, many thousands of trees died during 1908, on account of the long drought, owing to their not getting the start one had reason to expect in March and April, and those that survived were greatly weakened and took some time to recover, even with the good rains that fell from October onwards.

Those trees, however, which were over 6 ft. high before the failure of the rains suffered little, if at all. This was probably because the tubers were able to supply the trees with sufficient moisture to keep them alive. It is on this account that I cannot help associating the uncertainty of the latex in the trees to either an over-abundance of tubers below the ground, and a weakening of the tree above, or a possible lack of tubers and an insufficiency of moisture in the tree, which is, so to speak, always pumping up the water from the soil. This, thanks to the action of direct sunlight, enables the leaves to accumulate great quantities of starch and sugars.[1] At night there is

---

[1] *Hawaii Bulletin* 16, on "Ceará Rubber."

a transfer of carbohydrates in soluble form *from* the leaves to those parts of the tree where growth and the formation of new tissues and latex are taking place. It seems to me, therefore, that the tubers may play an important part in determining the latex-yielding properties of the tree, and that by a process of selection the planter may, if this idea is correct, be able to assure a more certain and even yield of latex than the Hawaii trees, at any rate, gave, although all outside circumstances, as soil, climate, method of tapping, &c., were the same.

Meanwhile, the British East African authorities consider that, once the trees are 6 ft. high and over, they need have no undue fear of a drought. The trees will not prosper, but, on the other hand, they will not die.

According to Mr. Williams, their year, from a planting point of view, begins at the end of the long rains in May, when the bush is cleared off. The trees are then planted 12 ft. by 6 ft., with the idea of leaving them 12 ft. by 12 ft., the rest being "tapped to death" in two years or so. Meanwhile the seed-beds have been planted, and the seedlings coaxed along to be

planted between October and December, when the rains are on. In East Africa, porcupines give trouble, as they dig up the tubers and eat them. In such cases a low wide-meshed wire fence is the best remedy.

At the Rubber Exhibition we were told that when growing rubber in East Africa, the special advantages of that part of the globe should be remembered; for, whilst waiting for the rubber to mature one can grow catch-crops, as cotton, ground-nuts, maize, &c. These not only yield a profit of from £2 to £5 an acre, and so help to cover the cost of laying out the estate, but should also, especially ground-nuts, help to keep down the grass, which many planters complain of at the start.

In German East Africa the "Lewa" system of tapping is practised, and it is claimed that by this method Ceará trees can be profitably tapped from about the end of the second year to the tenth year continuously. The system is described as follows: "The surface to be tapped is freely coated with the juice of sour citrus fruit, such as a lemon, lime, or sour orange. The bark is then horizontally stabbed with the point end of a knife, having a thin sharp edge,

at distances of about 3 in. apart. The milk immediately exudes, and quickly coagulates on the trees, when it can be collected and made into balls within an hour afterwards. Vinegar and weak carbolic acid can also be used for coagulating the rubber. If no acid is applied it will be found that the greater part of the milk is wasted in the ground." The rubber has then to be dried thoroughly and made ready for shipment.

When vertical tapping is used, the cuts should not be less than 5 in. apart, and enough uninjured bark must be left to admit of rapid recovery, or the vital processes of growth will be interfered with.

Mr. Kelway Bamber, I think it was, mentioned a method of "pricking" that would be more reliable than the "Lewa" knife-stabs, although I much prefer a multiple pricker similar to the one I designed. A leather shield, the size of the area to be tapped, has nails (with sufficiently large heads to avoid their going through the leather) driven through it at such distances as it is required to make the punctures in the bark. All the nails being of the same length, protrude through the leather at

equal length, and this length, of course, must be no longer than it is thought good for the hole to be made, to penetrate into the bark. The leather and nails are then laid against the tree and hammered home quickly, but by regular and even blows, with a good-sized wooden mallet. As soon as this is done, one corner of the leather is seized, the whole ripped off, so as to leave the tree neatly punctured, and the sap allowed to flow. In Ceylon it seems to coagulate on the tree, and a rubber plaster instead of the leather one is next ripped off; but perhaps elsewhere a wide V cut can conduct the latex to a cup, best tied on, to receive it. The area treated in this way should not be too large, a foot square should do well, otherwise before the time the malleting is finished the latex will be out. The same apron can be driven home in several places probably, and if one below the other, the one V cut would catch the latex for all. The outer bark in either case must, of course, be stripped off. With the "Lewa" method, rubbing with sour citrus fruit could well be tried, as the juice is a great cleanser,[1] and apparently assists coagulation.

[1] Nothing cleans brass so well in the Tropics as lime-

WILD *v.* CULTIVATED RUBBER.

By W. H. Johnson, F.L.S.

Author of "The Cultivation and Preparation of Pará Rubber."

To those well acquainted with the conditions under which wild and cultivated rubbers are produced, the various reports published, prophesying the ousting from the market of the wild by the cultivated product in the near future, cannot but appear over-sanguine.

The principal source of wild rubber is *Hevea brasiliensis*, which is also the rubber tree most largely cultivated.

There is very little doubt that rubber can be obtained at present from cultivated trees of this species less expensively than from indigenous trees.[1] But it is also true that in the majority of cases the first-mentioned product cannot be

---

juice, and failing that, sour oranges. The latter are also used for loosening the dirt when scrubbing floors and very dirty areas.

[1] Cultivated rubber may, at present, be landed in London at a lower cost than Brazilian indigenous, but that is only on account of the export taxes, and the lack of organization as regards foodstuffs at the rubber centres, cheap transport, &c.—Editor, *Tropical Life.*

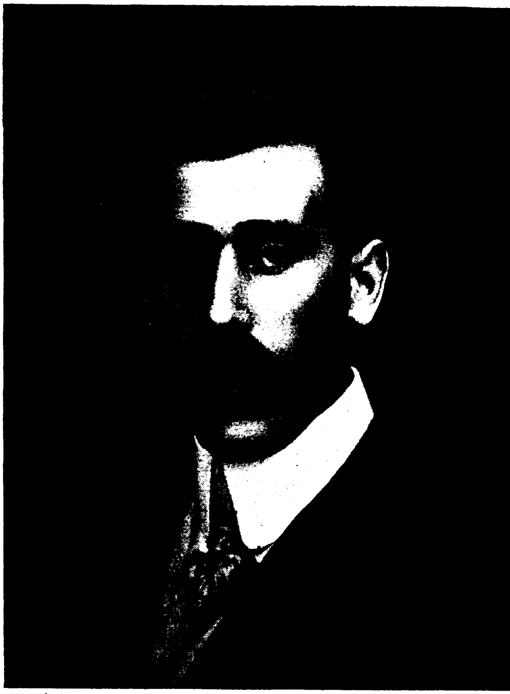
employed in the manufacture of all the articles for which the latter is so much in demand. The results of chemical analyses made of the latices yielded by wild and mature cultivated trees show there is no material difference in their composition. It can therefore only be inferred that the variation in the rubbers produced from them is due to the different methods employed in preparing the rubber for market.

These methods are well known, and do not require reiteration.

The tedious Brazilian method involves considerably more labour than those adopted by planters, and is consequently more expensive. But for cultivated Pará rubber to successfully compete with the Amazonian product it must possess all the properties which make the latter so much esteemed. For example, although it has been recently reported that "cut thread" has been successfully made from plantation rubber, its application is by no means general for this purpose, nor for the manufacture of other articles for which Brazilian Pará is in great demand.

The Brazilian method of preparing rubber is

naturally much too tedious to be generally adopted on plantations,[1] but, in view of the



[*Photo by Elliott and Fry.*

W. H. JOHNSON, F.L.S.,
Director of Agriculture, Southern Nigeria.

[1] Modern machinery like the Da Costa plant, invented by a Pará man, will entirely do away with this objection to the Brazilian method.—ED. *T.L.*

numerous methods employed since the establishment of the rubber-planting industry, it is next to incomprehensible that a satisfactory and expeditious method of preparation has not been evolved which would ensure the incorporation of those valuable agents in the latex which the Brazilian method involves.

The fact that the Brazilian collector extracts nothing from his latex, but antisepticizes its putrescible ingredients, is also a point which merits more serious consideration than it has apparently hitherto received. The elimination of putrescible bodies from the latex certainly decreases the rubber. Does this not also adversely affect the nerve and strength and also the keeping properties of the rubber? Again, "fine Pará" is coagulated in thin sheets in the form of concentric layers, and this may also tend to increase its strength.

It is reported that "fine Pará" loses from 10 to 20 per cent. of its weight on washing, whereas cultivated "Pará" only loses 1 per cent. in the same process. The latter product is employed by manufacturers for special purposes, and partly on this account, but more especially because of its greater purity, it has

up to date realized higher prices than "fine Pará."[1]

The higher prices paid for the cultivated product are, however, not commensurable with its greater purity. If 15 per cent. and 1 per cent. be a fair average loss sustained in the washing of "fine Pará" and cultivated Pará respectively, then, were the caoutchouc of each of equal value, the market value of "fine Pará" should be 14 per cent. less than that of cultivated Pará.

In the subjoined table an attempt is made to show the average price of cultivated "Pará" and "fine Pará" during the last six years, and also the rate per cent. lower price which "fine Pará" realized in comparison with cultivated Pará:—

AVERAGE PRICE OF CULTIVATED PARÁ AND FINE PARÁ FOR THE YEARS 1903-08.

Year	Cultivated Pará s. d.	Fine Pará s. d.	Rate per cent. lower price of Fine Pará
1903	4 7	4 1	10·9
1904	5 3	4 8	11·1
1905	6 4	5 6	13·2
1906	5 10½	4 3	10·6
1907	5 2½	4 7½	11·1
1908	4 2	3 11	6
Average	5 2·8	4 8·1	10·7

(In April, 1910, Plantation reached its record of 12s. 10d. only, against 12s. 6d. for Fine Hard.)

[1] Since hard Pará has up to 20 per cent. of water.—ED. *T.L.*

It will thus be seen that instead of "fine Pará" realizing a price 14 per cent. lower than that realized by cultivated Pará its average price for the six years was only 10·7 per cent. lower. In other words, the Brazilian product was actually rated at an average price of more than 3 per cent. higher than cultivated rubber.

By the Brazilian method, heat, acetic acid, creosote, and carbon, are applied to the fresh latex. The last-mentioned agent is probably a negligible quantity. Acetic acid and creosote have been employed in the preparation of plantation rubber both separately and in conjunction. Is it not possible, however, that the application of heat together with acetic acid and creosote would give better results? To accurately determine the quantity of each agent to apply, would necessitate considerable research, but if brought to a successful issue the benefit accruing to the plantation industry would be incalculable. The oft-repeated statement that the rubber-planting industry is in its infancy is only true to a certain extent, for it is rapidly becoming a somewhat aged infant, seeing that cultivated rubber has been exported from Ceylon for more than twenty years.

Cultivated rubber is now placed upon the market in a dozen different forms prepared in as many different ways. The fact that buyers have not definitely decided which method of preparation or which form of rubber is preferable appears to clearly indicate that a sufficiently high standard has not yet been reached, and the sooner a decision is obtained on this point the better it will be for all concerned.

The earliest recorded export of "fine Pará" from Brazil is given as 1829, and from that date to this it has been recognized on the rubber market as the standard product. Should not this fact alone afford sufficient inducement to rubber planters to endeavour to make their produce resemble "fine Pará" as closely as possible? That cultivated Pará rubber frequently lacks strength and nerve is probably due, in many cases, to the tapping of immature trees.

It is well known that rubber trees are not generally tapped in Brazil until they are from 10 to 15 years of age, whereas rubber has on many occasions been extracted from trees 5 or 6 years of age on Eastern plantations.

It is highly improbable that a Hevea tree can

reach maturity in five years, and if the tree is not mature at that age it is still improbable whether the latex will be; and the rubber prepared from it would consequently be of inferior quality.

Eastern planters assert that they can place their produce on the market at a cost of 1s. 6d. per lb. On the other hand, it has been frequently stated that this cannot be done with "fine Pará" under 2s. 3½d. per lb., and that when the price of this product falls below 3s. per lb. it is sold at a loss.

Such statements, however, require substantiation. They are frequently denied by persons who claim to be well informed with regard to the conditions under which the Amazonian rubber trade is conducted. Much of the rubber is obtained by bartering goods so that a double profit is often derived. In any case it is well to bear in mind that "fine Pará" was sold, apparently at a profit, at from 3s. to 3s. 6d. per lb. between the years 1877 until 1898, excepting only the years 1882 and 1883, when it rose to slightly over 4s. per lb.

That the Amazonian administrations appreciate the necessity of taking steps to contest

their Eastern competitors is amply exemplified by the recent decisions to regulate rubber taxes.

The stoppage of rubber collecting in the Amazon Valley would convert it into a state of bankruptcy. Is it likely, therefore, that these administrations will permit, without strenuous efforts, an industry to die out which annually yields such handsome revenues? Enormous areas on which rubber-producing trees are known to abound have not yet been exploited. With improved transport facilities in the shape of railways and river craft better adapted to the conditions obtaining on the higher reaches of the tributaries of the Amazon, there is every prospect that the exports of rubber will continue to increase for many years to come.

The world's demand for rubber is supplied by South America, which contributes 63 per cent., and Africa and Asia, the last two contributing 34 and 3 per cent. respectively. The supply from South America is annually increasing. An attempt has been made elsewhere to show that the supplies of African rubber are not decreasing so rapidly as is generally reported.[1]

[1] "The Cultivation and Preparation of Pará Rubber." Johnson. Second edition. Crosby Lockwood and Co. Price 7s. 6d. net.

The Landolphias and similar plants from which the bulk of African rubbers is collected are wonderfully prolific. Although slow of growth as compared with *Hevea brasiliensis*, wherever systematic attempts are made to conserve the young plants and prevent excessive tapping the number of productive plants tends to increase rather than diminish.

The amount of ignorance displayed by some writers who profess to be well acquainted with the wild rubber industry is surprising, in regard to the quality of African rubbers. The following remarks which recently appeared in an agricultural bulletin published in the East is particularly noteworthy in this respect: "So far, only dirty, badly-prepared rubber has been put on the market from Africa, and some of this loses as much as 50 per cent. weight in washing."

Now such a loss is comparatively rare even with African rubbers, while many lose very little more than "fine Pará."

The following is an analysis made at the Imperial Institute of a fair sample of rubber produced by *Landolphia Kirkii* in the Moçambique Company's Territories, East Africa, *i.e.*:—

	Per cent.
Moisture	5·0
Caoutchouc	85·6
Resin...	5·5
Proteids	1·3
Insoluble	2·7
Ash	0·46

It would thus appear that the purity of this rubber compares favourably with "fine Pará," and the same may be said of several other grades of rubber which are exported from West Africa.

Granted that these rubbers realize inferior prices to cultivated Pará rubber, it must be remembered that, on the other hand, despite numerous statements to the contrary, a large quantity of such rubber can be placed on the market at a cheaper rate than the price at which Eastern planters affirm they can market their product.

The preceding remarks have not been written with the intention of in any way disparaging the cultivated rubber industry, but rather with a view of demonstrating the strong position of its rival and the urgent necessity for remedying the defects in the cultivated product. Unless the demand for rubber increases at a greater rate than that which has obtained during recent years, it must be patent to all concerned that

there is going to be very severe competition in the rubber-producing trade in the near future.

Before that time arrives it behoves all those interested in the cultivated rubber industry to endeavour to make their product not only equal to, but superior in *all respects* to the best wild rubber placed on the market.

MECHANICAL APPLIANCES.

PLOUGHING.

PLOUGHING ON CACAO AND RUBBER ESTATES.

Two new parasitic fungi on rubber trees should be noted—the dangerous black *Diplodia rapax*, and the *Hymenochæte.* Mr. Petch tells me the *Diplodia rapax* is a new name for *Diplodia*, which has been known to attack Hevea in Ceylon, India, and Burmah since 1905, and which has been known on cacao since 1896. It is the old enemy of the West Indies. *Hymenochæte* has also been recorded in Ceylon many times since 1905, and was known as a parasite in Samoa fifty years ago. There seems to be some hope that lalang ground, in spite of trouble from the grass, may be less liable to fungi attacks. What I am glad to see by the *Straits Bulletin* is that "many planters are now stubbing their estates with a view of destroying the parasitic

root fungi remaining in the ground from the relics of the original forest trees, and ploughing, both with the native ploughs and disc ploughs, is being resorted to." I have been discussing this question of ploughing rubber estates with experts on this side, and feel certain that where *Fomes* or other fungous trouble is present, planters will have to plough. Mr. Gallagher reports that on most estates in Malaya now, the planters are steadily working from the older to the younger rubber, taking out all the roots and burning all the dead wood. Only one or two are destroying all the timber before planting.

Deep, or moderately deep, cultivation with the plough not only serves to turn in the weeds and utilize them to fertilize the soil, but it brings to the surface and lays bare to the air and light an enormous amount of decayed vegetable matter, which is the indirect cause of the trouble, and which is not available as a plant food until thoroughly aerated and sweetened by the action of the sun and atmosphere. After such a subsoil has had some weeks' exposure it can be broken up by a harrow, and will cause little or no trouble

compared to the uncultivated soil, on account of fungous growth.

The choice of implements for cultivating rubber or cacao land depends, of course, greatly on the nature of the soil and the class of cattle and labour available, *i.e.*, if the land is heavy, or forest or scrub has to be dealt with, a strong plough will be required, especially for the first ploughing of the new land (Stockdale prefers a disc plough here, as a rule), as well as for deep cultivation, which is to be recommended for all tropical countries when first preparing the land for crops such as cotton, rubber, sugar-cane, &c.

For the first ploughing in new virgin soil, 4 to 6 in. deep will be sufficient. When the soil has had a few weeks' exposure, and the tree stumps from the original forest growth allow, the disc harrow is an excellent implement for cutting up the sods and preparing the land for the next ploughing, which should be done a few inches deeper than the first ploughing. If there is a sufficient area of land to be dealt with, and the draught animals are available, a disc plough, which is made in sizes from one to four furrows, is an excellent im-

plement for this second ploughing, as it would effectually bury the old sods and pulverize the soil better than a share plough. After another spell of cultivating and harrowing, the land should be ready for any crop, but if not, use cultivators.

For working and cultivating crops planted in rows, light ploughs and small cultivators are most suitable for keeping the weeds in check, but a good deep ploughing should be given at least once a year to crops such as rubber, sugar-cane, &c., where it is possible, in order to keep the ground sweet, and prevent fungous growth spreading.

The ridging plough is a most useful implement for any crop such as rubber, tea, cotton, sugar, &c., as it can be fitted with hoes for cleaning the crops, as well as breasts for banking up the plants when necessary.

Mr. J. Johnson, manager of the Kabete Government farm, writing on tillage in the *Agricultural Journal of British East Africa*, for January 1910, said that "the disc was a type of plough worthy of notice." He considers that it works very satisfactorily indeed in the red soil, which owing to its peculiar adhe-

siveness often causes trouble with the mouldboard plough. The disc obviates all this, for, on account of its construction, the disc in cutting out the section of soil is continually revolving and the attached scraper effectually ensures that the implement is always clean. The framework of a disc also enables it to do effective work amongst quite long growing weeds, &c. The low frame travelling first, bears down the long grass in front, the disc comes along and turns over the root into the bottom of the furrow, while the stem is then gradually and neatly folded in and completely covered up. Altogether the process is entirely satisfactory, and nothing whatever is lost to the soil by weeds having first to be hoed and then burnt off. Disc ploughs may have as many discs as the farmer considers desirable or has oxen to pull them. Under ordinary conditions 10 oxen can negotiate a 2-disc plough, while for a 3-disc, 14 may be required. The discs can be set to take large or small furrow slices up to 12 inches. They have the same action as a short mouldboard plough, taking the furrow-slice out and completely reversing it, at the same time pulverizing it thoroughly. Mr.

Johnson reports having seen these ploughs working in the Limoru district, and has no hesitation in recommending them as being very suitable for the peculiar class of soil which has to be dealt with there. They are very strong and get over a large area of ground per day.

The depth, he went on to explain, at which to plough, depends entirely on the character of the subsoil. If this is of a texture and substance entirely different from the surface soil, then it would be well to leave it where it is.[1] If it were brought in quantity to the surface, germination of small seeds would be impossible until the action of rain, sun and wind had "sweetened" it. Ordinarily the first time land is ploughed only a slice 3 to 4 in. deep is taken, while with the next and following ploughings various depths down to 9 in. or over may be taken. Ploughing always at the same depth would be liable to form what is termed a "pan" in the soil. This is a consolidation of the subsoil at a certain depth into a hard, practically impermeable layer, which neither allows of the free access of roots, air or water.

[1] This should certainly be the case in Malaya, with its peaty soil on the top of clay, and also on rice soils.

For breaking up this "pan," and allowing the water to percolate freely, a subsoiling plough is used, of which there are various types. This plough simply stirs the soil, breaking it up where it is, and does not bring it to the surface. This object is also achieved by the use of cultivators, an excellent machine of which there are several kinds.

The *American Journal of Agriculture*, in describing the connection of water and soil, explains that the water deep down in the soil is attracted and drawn towards the surface of the soil by the grains just above it, after which the soil particles above the first lot again attract and draw up the water to their surfaces; so in turn the different layers of soil particles draw the water to themselves, and so on up higher and higher till it reaches the outside surface. Once at the surface the air claims the water, and it is taken away from the soil by evaporation. Soil particles not only have the power to attract water, but to hold it as well. By a simple mathematical law, the smaller the particle the greater proportional surface it has, hence the finer the particles are, the more water a given quantity of soil

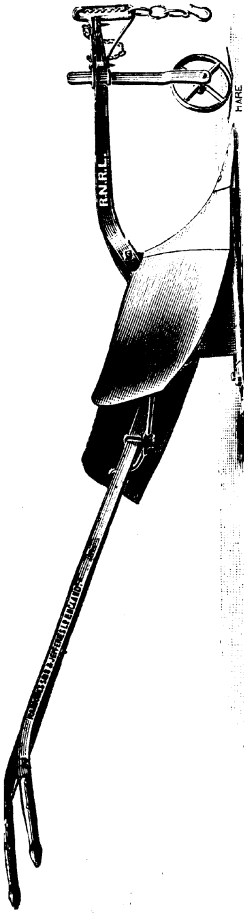
is capable of holding. Also the closer together the soil grains are (up to a certain point) the more retentive is the soil of the moisture it contains. For this last reason, deep ploughing for breaking up large masses into fine grains, and heavy packing to bring these fine grains into close contact, are employed in dry farming operations, and may be adopted in any region in dry seasons to make deep soil hold large amounts of water. The planter, whether working damp or dry soils, who understands fully the laws of capillary action, and so learns to handle his soil that it may receive, and if necessary retain, the required amount of moisture, has mastered one of the greatest points of successful cultivation.

Soil-sanitation by means of Disc Ploughs as a possible Remedy for Fungous and other Diseases on Estates.

As already stated, I have been carrying out a series of inquiries and investigations with ploughing experts and directors and managers of rubber estates, in connection with the possibility of minimizing the danger resulting from, if not of actually curing, *Fomes* and other root

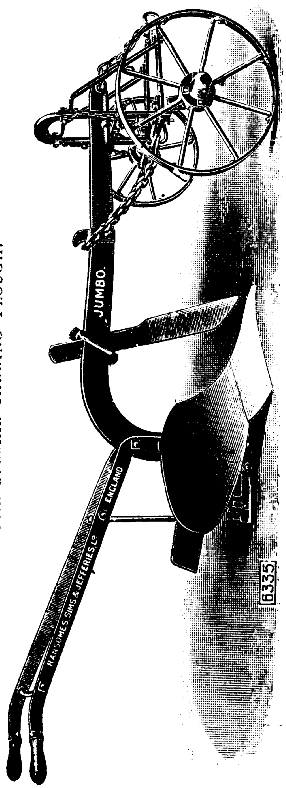
troubles that are attacking Pará rubber in the East. I have all along maintained that where root trouble prevails ploughing must be adopted, for even if it is at times harmful to the surface roots, as opponents to doing so claim, the damage so done is small in comparison to the benefits conferred on the tree by the admission of light and air to the subsoil, both of these being sworn enemies to fungus growth.

I do not claim to be a ploughing expert, but started with the idea that, for the purpose of root sanitation, the disc plough would be best, as being likely to give the largest amount of exposure to the subsoil and roots with the least disturbance and damage to the roots either of rubber or cacao trees. Now I learn that rubber planters in the East are using the native and disc ploughs, with a view of destroying the parasitic root-fungi, of which we hear so much, and will hear still more of if a remedy is not discovered. The following particulars that I have collected, in connection with ploughs for rubber and other estates, from those who have had long experience in the matter may be of use to planters anxious to learn something of



883A

THE SPECIAL RIDGING PLOUGH.



THE "JUMBO" PLOUGH.

the ploughs suitable for the various kinds of work in connection with tropical cultivation :—

(1) *Jumbo Gallows.*—Extra strong single-furrow plough, for breaking up new land with roots and stones, or for extra deep cultivation. Makes broken furrows.

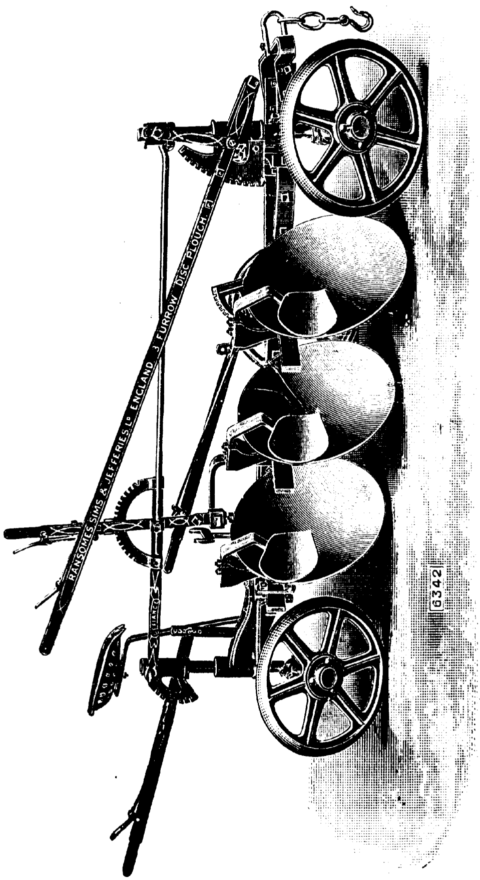
(2) *S. A. E. Gallows.*—Medium weight, single plough, for breaking up new land free from roots and stones, or for moderately deep cultivation. This plough can also be fitted with one or two fixed wheels if desired. Makes broken furrows.

(3) *Y.C.P.W.*, 1-*Wheel.*—Strong, single plough, for sugar-cane cultivation ; makes moderately clean furrows.

(4) *Disc Plough,* 3-*Furrow.*—Suitable for general ploughing on dry, hard soils ; moderately deep cultivation. Makes broken furrows, invaluable in dry, arid countries, where the land has to be ploughed in a dry, hard state, so as to be ready for seeding when the first rains fall.

(5) *Ridging Plough, R.N.R.L.W. Special.*—Suitable for banking-up sugar-canes or other crops. Can also be fitted with hoeing apparatus, for hoeing between rows of cotton, sugar, &c.

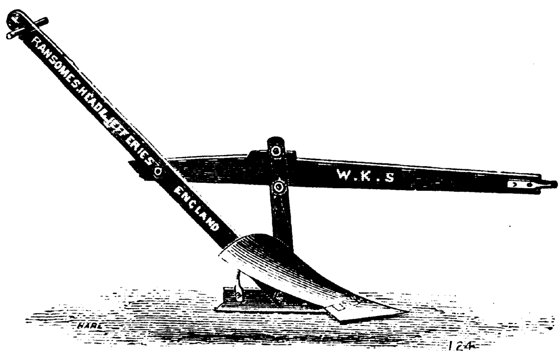
(6) *E.C.*, 1-*Wheel.*—Light, single plough,



A 3-Furrow Disc Plough.

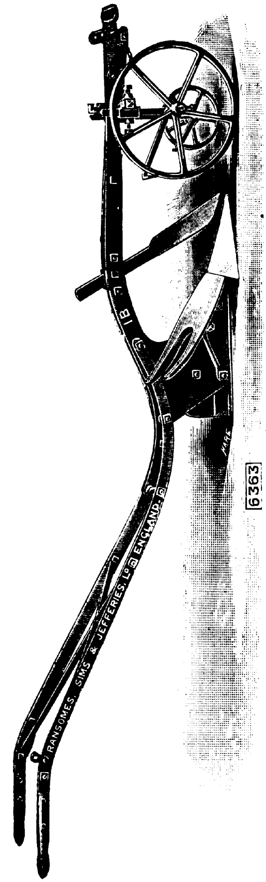
suitable for ploughing between rows of rubber, cotton, &c. ; also for general ploughing on light and medium soils.

It is important to remember that different soils and conditions require different types of ploughs. Because, therefore, the results from a first attempt are not satisfactory, that need not mean that ploughing was unnecessary or even harmful, but would more probably be due to the wrong class of plough having been used,



Plough for Cultivation and Light Work.

at a certain stage in the cultivation. Later on, the plough which at first did unsatisfactory work may be just the one to use, for as the soil gets broken up and cultivated quite a different implement is required to the one used for first breaking up the ground.



Plough for First Ploughing in New Virgin Soil.

MODERN METHODS FOR DESTROYING INSECT PESTS.

BORDEAUX MIXTURE.

The war against insect and fungoid pests is one that is being waged more fiercely every year all over the agricultural and horticultural world, and each season sees some acquisition to the strength on both sides ; but, slowly yet surely, man is gaining the upper hand, for while each season finds some new disease brought about by the changes of economic conditions, and the facility for the spread of pests, due to international transport and closer cultivation, many of our best intellects are successfully at work in all parts of the world, devoting their energies to the obtaining of a better understanding of the life-history and the remedial measures for pests of all sorts—animal, fungoid, and bacterial—and that these efforts are not without success may be recognized at once by reference to the various and valuable bulletins and other literature, published by our different agricultural departments, each studying the special problems arising in their particular area, the results generally being also of value, how-

ever, outside their own special "sphere of influence."

Research work is also being carried on by private investigators, among whom must be mentioned the Duke of Bedford, F.R.S., and Mr. Spencer Pickering, F.C.S., who have for some years been issuing reports of their investigations.

In their eleventh report of the "Woburn Experimental Fruit Farm," the subject of Bordeaux Mixture is extensively dealt with.

Beyond the fact that it was effective in checking and destroying many fungoid diseases, very little was known about the chemistry and action of Bordeaux Mixture until the investigations of Mr. Pickering, who has recently brought the chemical problems involved before the scientific world through the Chemical Society, and to the horticultural and agricultural interests through the medium of the "Woburn Reports." From this it appears that the benefit is due to certain insoluble copper salts present, being rendered gradually soluble by the action of the carbon dioxide in the air, such soluble salts then acting in the presence of moisture directly upon the

fungus, as well as indirectly by the changes produced in the tissues of the foliage, these changes rendering them more or less immune for a time at least. He also found that only a small part of the copper salts were in a form capable of undergoing this change on exposure to the air, and the value of the whole depends upon this part only of the Bordeaux Mixture as it becomes soluble, the rest of the copper salts present being valueless. Recognizing the practical value of the work on the subject, Mr. Walter Voss, F.C.S. (of the firm of Messrs. Walter Voss and Co., Ltd., London), approached Mr. Pickering, who very generously responded with his co-operation, as the result of which, what is known as the Woburn Bordeaux Paste (patent) was produced.

This Paste may be looked upon as consisting of the valuable and temporarily insoluble constituents of Bordeaux Mixture; the bulk of the permanently insoluble and, therefore, useless copper salts, the large quantities of calcium carbonate, calcium sulphate, and excess of lime being absent. This saving of the wasted part of the copper salts enables it to be marketed at a price which brings it

at less cost than the home-made preparation, while it also saves the clogging of the sprayers and avoids the unsightly coating of the foliage, as the small quantity of solid matters left in the spray makes very little show on the fruit and foliage.

As it has been found that the composition of the valuable copper salts becomes altered by drying, their solubility in carbon dioxide being impaired accordingly, it is sent out only in paste form. It is easily mixed with the required quantity of water, after a small quantity of such water has been first added, and the whole stirred sharply, with a handful of twigs, to break up the adherent masses of paste.

Care should be taken not to put Bordeaux Paste (or any copper fungicide) in contact with iron, tin, zinc &c. The colour of the paste, which should be a beautiful soft torquoise blue, soon shows the degeneration due to such treatment.

Sprayers and pumps should be clean and free from residues of other Bordeaux preparations, lime, soda, &c., or its composition will be altered and the paste spoilt.

Planters should also watch the experiments with "Fungal" which are being made. This preparation, which has so far received the highest expert approval, has been sent out to various departments of agriculture for practical trial on root diseases of rubber, cacao, &c., and if it meets with the success on trial that is looked for, it will be distributed commercially by Messrs. Walter Voss and Co., Ltd., London; but nothing will be done until receipt of satisfactory reports, as the firm referred to will not allow it to go on the market for any particular purpose without proof of its value.

Granted that the planter realizes the burden of increased responsibility imposed by the growing competition in the production of rubber, then it is clearly to his immediate interest to adopt a practical form of output and profit insurance, by taking the most efficient measures to build up the stamina of his trees, and develop and retain their valuable resources in full vigour and productiveness.

Having in mind the time when young trees will be in yield, the wise planter of new areas will exercise this protective policy by taking adequate precautions to guard his plantation

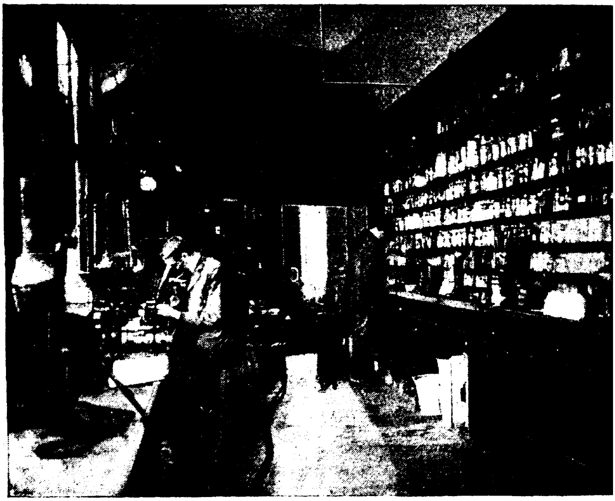
from the ravages of disease and insect pests, while the planter who has to increase the volume and quality of an established estate will seek to eliminate the main causes of unsatisfactory returns by providing nourishment for the impoverished soil, and destroying all apparent traces of disease and pests, thus guarding against further attacks.

To put this policy into effect Messrs. Robinson Bros., Ltd., of West Bromwich (England), offer planters the full benefits of an experience of over forty years in the working of tar and the preparation of its wonderful derivatives, and as many years intimate association with the manufacture of chemicals and artificial manures, consummated in world-known preparations and appliances for the destruction of insect pests.

Clift's Manurial Insecticide is a powder compounded with the most extreme scientific accuracy and care, in order to combine pest-destroying qualities of the most effective and lasting kind with a highly nutritive manure.

The soil, immediately upon being treated with this powder, is entirely freed from all ordinary insect pests, and is at the same time rendered uninhabitable by any such for three, or at least two years.

Notwithstanding this powerful and enduring action upon pests, the powder when used as directed will not harm the tenderest plant or root fibre, while its high percentage of soluble



RESEARCH LABORATORIES, WEST BROMWICH.

All Messrs. Robinson's preparations are manufactured under the supervision of a highly trained staff of expert chemists, who make frequent tests and trials at various stages of production.

and directly available plant foods renders it worth more than its cost as a manure and stimulant alone.

Clift's Fluid Insecticide is a highly con-

centrated fluid insecticide of exceptional strength for winter washing, local application, or the cleansing of tree trunks. Used in a strong mixture, 1 in 10 of water, or 1 in 20, it will destroy all noxious insects, including beetles, rhinoceros borers, shot-hole weevils, and caterpillars of all kinds. It will also be found most effective if injected into the warts caused by borers infesting the cambium of rubber trees after faulty tapping.

Clift's fluid can also be used as a preventive against these particular borers. Before tapping the tree should be washed locally with a 1 in 10 solution.

As a greater precaution against these pests the tapping areas should be isolated from the rest of the bark by surrounding them with a ring of Clift's thick fluid to prevent borers or any other insects from effecting a lodgment.

In cases of serious local infestation by the white ant, the watering of any area with a 1 in 50 mixture of the fluid will render the soil uninhabitable by this pest.

The fluid is also most useful in all situations where the powder insecticide may be temporarily inapplicable on account of the impossibility of at once digging over the soil.

Clift's thick fluid, painted in a ring round the tree, prevents the passage of any pest, and if renewed as it dries will, in all probability, stop rats and even squirrels from ascending the tree.

Robinson's Self-acting White Ant Destroyer (Protected).

An entirely new method of destroying white ants in hollow logs, tree trunks and ant-hills, or any substance where fumigation is possible.

The device is in the form of a tapered wooden cartridge charged with sulphur and arsenic, and ingredients to support combustion.

After drilling a $1\frac{1}{4}$-in. hole into the white ant cavity with an ordinary brace and bit the fuse is ignited, and the cartridge inserted into the hole. The poisonous fumes from the smouldering powder destroy all the insects present, and render the cavity permanently uninhabitable.

After discharge the cartridge can be driven into the log or tree flush with the bark and tarred over. Living trees can also be treated by this method for the destruction of termites without injury.

The system entirely dispenses with the use of high-priced fumigating machines, and the large contingent working expenses.

The cartridges are portable and easy to use. One man can carry a great many and effect a large number of fumigations in a day.

ROBINSON'S PRESERVATIVE WOOD STAIN, WHITE ANT BRAND.

A specially prepared preserving and staining

Messrs. Robinson's special entomological and experimental department attached to their West Bromwich laboratories is always at the disposal of planters and others when in doubt or difficulty as to the best methods of combating insect pests.

oil, rendering timber buildings and wood erections of all kinds quite proof against white ants.

The oils are readily absorbed by the wood, and carry with them soluble proofing ingredients into the fibres, to be permanently retained there.

Apart from its special efficiency in this direction, the other important features of Robinson's Preservative Wood Stain cannot be too highly estimated. It prevents dry rot, decay, damp, fungus, and the attacks of vermin, and in all respects adds life and endurance to wood.

It is supplied in two shades of green, two shades of brown, and one red; each is in the best of taste and gives a most attractive finish to every class of outside woodwork.

Robinson's Rat Guards is an invention designed to enable cultivators of the coconut to prevent rats from ascending the trees. It is an ingenious device made of wire, easily fitted to the trees and makes the passage of the animals impossible.

Robinson's Antiseptic Coagulant is a genuine antiseptic coagulant prepared from a highly successful formula, prescribed by one of the leading continental authorities on rubber. It rapidly coagulates latex into rubber of ex-

cellent substance, preserves it in fine condition, and prevents any kind of fermentation.

Dependability and Efficiency.—All preparations are manufactured under the strictest laboratory supervision, thereby assuring a degree of dependability and efficiency otherwise unobtainable.

Messrs. Robinson say that they will be glad to receive the inquiries of all who are anxious to avoid losses from the injuries of insect pests, no matter what crop is involved. In such cases planters are asked to send, so far as can be ascertained the life and habits of the pests; whether any part of their lives is spent in the soil or not, and if so for what period; how the insect attacks the crops, and the nature of the crops, with any other details that may be helpful in enabling the makers to advise which remedy to use, how and when to apply it to obtain the best results.

All communications, direct or through merchant shipping houses, sent to Messrs. Robinson Brothers, chemical manufacturers, West Bromwich, England, will receive immediate attention, and fullest particulars will be despatched by the next mail.

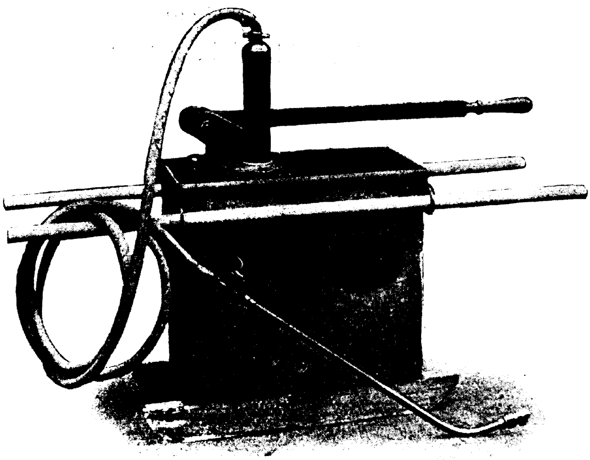
To be able to use the insecticides and fungicides recommended in this volume to the best advantage, the grower must provide himself with efficient apparatus, bearing in mind that the cheapest is often the dearest in the long run.

Messrs. W. Weeks and Son, Limited, of Maidstone, England, manufacture spraying machinery of all kinds. Their machines have proved themselves to be right in the front rank in no uncertain manner, as they gained both the First Prizes awarded by the Royal Agricultural Society for hand and power sprayers last year, as well as the First and Second Prizes for hand, and First and Second Prizes for power sprayers, at the Bath and West of England Agricultural Show last year, besides other First Awards.

Their hand-power spraying machines are strongly built and well-adapted for the rough usage they have to meet with. The pumps are very powerful, being made of solid gun metal throughout, whilst the valves are so designed as to be practically unchokable. Moreover, if, for any reason, they should require adjustment, the design of the machine is so simple that a mere novice can remove the

pumps, and take out and replace the valves in less than half a minute, which is a consideration of the utmost importance.

The machine illustrated is a very handy type

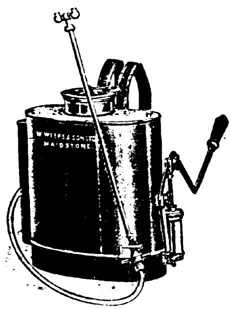


MESSRS. WEEKS' HAND MACHINE TO BE CARRIED WITH BAMBOO ROD.

for use on plantations where the growth is very close. They are constructed in any size to contain from 12 to 100 gallons each. Two poles or bamboos, put through the staples provided for them, enable the apparatus to be

carried about by a couple of men or boys. If the machine has two hoses and branches, as is usually supplied, it will require one man to each to direct the spray on to the trees, whilst a third is pumping.

These machines are very cheap to work, as they do not require skilled labour to use them,



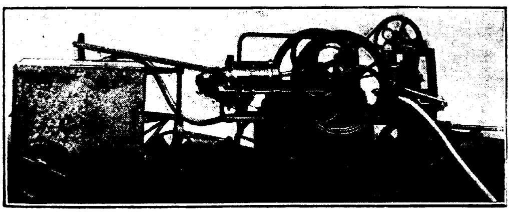
MESSRS. WEEKS' KNAPSACK SPRAYER.

provided the overseers take care to see that the spraying is thoroughly done. A large acreage can be covered in a day, and the benefits derived from thus cleansing the trees and exterminating pests are such as to give a return of many times the first cost of the machine even in one season.

The same firm also make a very useful knap-

sack sprayer which is specially constructed for dealing with all kinds of chemical washes. It has outside pumps, and all its working parts are of gunmetal, so that there is nothing to get out of order or become wasted away by the action of the chemical washes used.

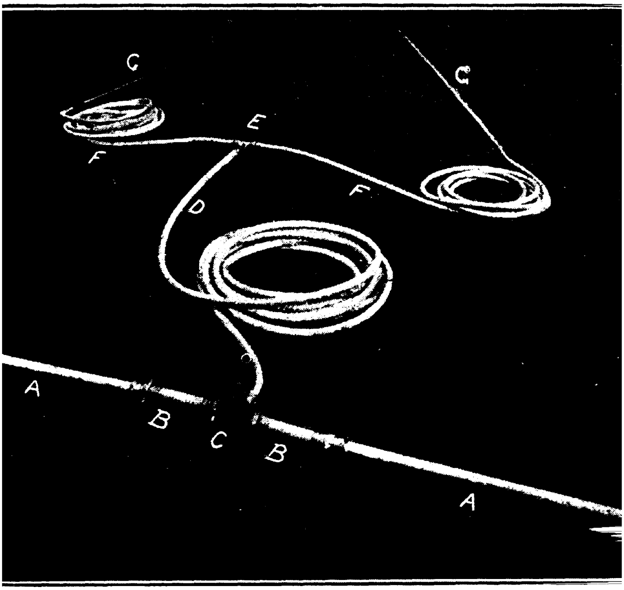
Messrs. W. Weeks and Son, Limited, also make power-driven spraying plants which are



MESSRS. WEEKS' POWER SPRAYING PLANT.

almost indispensable for large plantations. I understand that they have just supplied two of these to a firm of rubber growers for use on their plantations in the Malay Peninsula. The engine and pumps, with separate tank for the wash, are shown in the above illustration. The engine may be oil or petrol as desired, and the pumps are made of varying capacities, dealing with from 700 to 2,000 gallons per

hour. The smallest size is sufficient to easily supply eight nozzles for most purposes, and it



A, 15 ft. lengths of light steel galvanized tubing; B, flexible connectors; C, three-way cock; D, 60 ft. of main hose; E, T-piece at end of main hose; F, lengths of hose leading to nozzles; G, spraying branches and nozzles.

will be noted that a stirring arrangement is provided by means of which the wash is kept thoroughly mixed. The system of piping

generally adopted in connection with these power plants is also shown. The main consists of a series of light galvanized steel pipes, having screwed ends connected by flexible connectors, each consisting of a short length of armoured rubber hose fitted with swivelling lug-nuts. At intervals of every few lengths of pipe a gunmetal three-way cock is inserted, to the outlet of which is attached the rubber hose. These cocks are so arranged that the supply can be entirely shut off—open to the main or hose only—or open to both. The 60 ft. length of main hose, attached to the cock, is fitted at its other end with a T-piece leading into two further lengths of hose, each 30 or 60 ft. long, to the ends of which are attached the spraying branches or nozzles. (See p. 520.)

It will be seen that an area 60 ft. by 120 ft. can be sprayed with each set of hosing as described, if two lengths of hose, each 30 ft., are used; and an area 120 ft. square, if two lengths, each 60 ft., are used. A main consisting of well over one hundred 15-ft. lengths of steel piping can be used without appreciable loss due to friction, so that an area of over 1,500 ft. by 120 ft. can be sprayed with one

laying of the main. The pipes of which the main consist, are made of specially light galvanized steel tubing, so that a man can carry from four to six lengths at a time, and when the area at the end of the main has been sprayed, the supply can be turned off at the nearest three-way cock, and the piping out of use shifted to a new area.

With this system, as much as 23 acres of apple orchard have been thoroughly sprayed in one day, but of course the acreage covered must depend upon the density of the growth to be sprayed. (This plant can also be used for ordinary pumping purposes for water supply, &c., &c.)

One word in regard to the Weeks' Patent "Multi-spray" nozzle which the firm supplies with their machines. It is an exceedingly ingenious arrangement, which enables the grower to obtain any kind of spray he may desire, between the finest and softest mist and a long powerful drenching jet. It is adjusted by merely turning the cap and has clear passages, so that it is practically unchokable. The advantages of using this nozzle will be apparent, as it combines the uses of three or

four of the ordinary pattern, and is adaptable for all purposes ; either to foliage spraying, or to centralize, on a given spot, a cacao pod or pods, a diseased limb, or angle in the trees. The machines can be supplied either in knapsack form, or as tanks to run on wheels, or to be slung on bamboos and carried.

———

THE QUESTION OF CORK-INSULATION.

Before long, and especially as the output of plantation rubber increases on individual estates, planters, if they are wise, will turn their attention to the question of cork-insulation, not only for their private residences and offices, but also for estate buildings, particularly rubber dairies or factories where a low, even temperature is highly desirable. In Germany corkboard insulation has been used extensively for lining residences to keep out the cold, and so help to warm the rooms. In the Tropics the same corkboard could, with equal and even far greater benefits, be used to keep *in* the cold, and so maintain a low

uniform temperature throughout the building, or such part of it as it is necessary to line. A good lining of corkboard under the roof alone would help to reduce the temperature by several degrees, and to keep it low.

With wooden buildings the cork sheets could be nailed to the studding and the surface plastered with Portland cement. Furthermore, the cork in granular form can be moulded to any form and shape, and so (the same as I noticed in the infectious wards of the Pasteur Institute at Paris, and in the Middlesex Mortuary, London) all nooks, corners, and angles could be rounded off, the walls and the flooring being of one and the same material—viz., compressed granulated cork covered over with an unbroken surface of cement. This would offer a distinct gain in cleanliness, and in facilities for keeping out dust, dirt, and any foreign matter, so detrimental to high-grade rubber. With it you are bound to have what at present must be regarded as perfection in the matter of a cool sanitary dwelling, and which, I imagine, would not cost very much more than a building of the ordinary type, and less than some of the more pretentious build-

ings being erected. The thickness of the boards would vary according to the circumstances, and it would probably be found better to use two thin boards than one thick one, as the two boards, by overlapping, ensure an absolutely complete covering of all joints.

Possibly in the Tropics, to keep out extreme heat, the same as elsewhere to keep out extreme cold, thicker boards would be necessary than are required here or in Germany, but that is but a detail. Probably, as stated above, it would be desirable to employ artificial refrigeration, or some other means to lower the heat in the first place, as, once this is done, the cork-lining would maintain it at the reduced temperature at little or no extra expense. If the idea is feasible, it would make the work and life of a rubber or other planter and his employés in the Tropics much more pleasant, healthy, and comfortable; and, therefore, although I have not seen the idea mooted from other quarters, I feel that the sooner the insulation engineers and contractors meet the rubber and tropical planters to discuss the best way to make a start in the matter the better for all concerned. There are several

manufacturers of granulated cork, which is made up into compressed sheets of convenient sizes—12 by 36 in. I know is one of them—and of any thickness, as required. They can be supplied of pure cork only or with a cement surface firmly welded on. To keep away white ants, and possibly other pests, the granulated cork would have to be first well soaked in Atlas Preservative or other anti-formica or wood preservative at the time of being made into boards. This would probably be an advantage, and help to bind the whole together, if used with discretion and not too freely, so as to harden and pickle the cork and reduce its powers of insulation.

I understand the cork board can easily be erected in any sort of building whether the frame be of brick, stone, wood, or concrete. Against sheathing or studding it could be nailed; against brick or concrete walls and roofings or ceilings it could be laid up, like tiles, with Portland cement mortar. Once erected, the whole of the room—walls, roof or ceiling, flooring, angles and corners (nicely rounded off)—could then be finished off with a coating of Portland cement plaster, and so

present an even, continuous, unbroken, or uncracked surface for dirt, &c., to rest on, or if resting there to be immediately detected and removed. Meanwhile, if properly erected, the whole building could be made an absolutely solid construction, without any crevices whatever to harbour vermin (rats, insects, &c.), and can be swept and washed, even have the hose turned on it, without harm. Surely, also, such a building, too, would minimize the risk of fire, for even if it caught, which must take place underneath the surface, such cork is a poor fuel, much more liable to smoulder than to flare up before the smoke shows that there is trouble about. I have said sufficient about this for the present; I did not mean to say so much, neither have I consulted any expert as yet on the subject. I wrote to one, but receiving no help, I have elaborated the matter "off my own bat," and from my own knowledge of the matter, gathered together since I noticed in the *Agricultural News* of Barbados an account of the s.s. "Tortuguero,"[1] a vessel of some 5,000 tons, specially built for banana transport. This

[1] See *Tropical Life*, June, 1910, p. 109.

vessel contained insulated space running into 220,000 cubic feet, of which 175,000 cubic feet were occupied by fruit bins, in which the cork for insulation had a thickness of 7 to 8 in. Since then I have been making a careful study of the question of cork-insulation for tropical use in order to include some particulars on the subject in this book.

In the Tropics when erecting buildings of wood, or even those with only the uprights, cross beams or struts of wood, the depredations and damage from white ants, borer beetles, as well as other insects and fungus, frequently result in very serious losses, particularly in cases where the woodwork affected is not visible or accessible. To avoid this, it is essential that all building timber should be treated with a preservative possessing antiseptic and insecticidal properties, of proved efficiency in protecting timber from the attacks of insects, and preventing dry rot and other forms of decay. This undoubtedly will be doubly necessary with cork insulation if adopted for rubber factories, residences, &c., in the Tropics.

From my experience of Atlas Preservative

A," I have suggested that experiments be carried out to ascertain whether after the immersion of granulated cork in solutions of this preservative its insulating properties would be impaired. There is no doubt that if the cork could be treated with Atlas "A," either before or after compression, it would be effectively protected from white ants. An advantage of the Atlas treatment is that it can be applied either by painting over the surfaces or by immersing the material before erection. At the same time all the woodwork in connection with the buildings should be thoroughly treated.

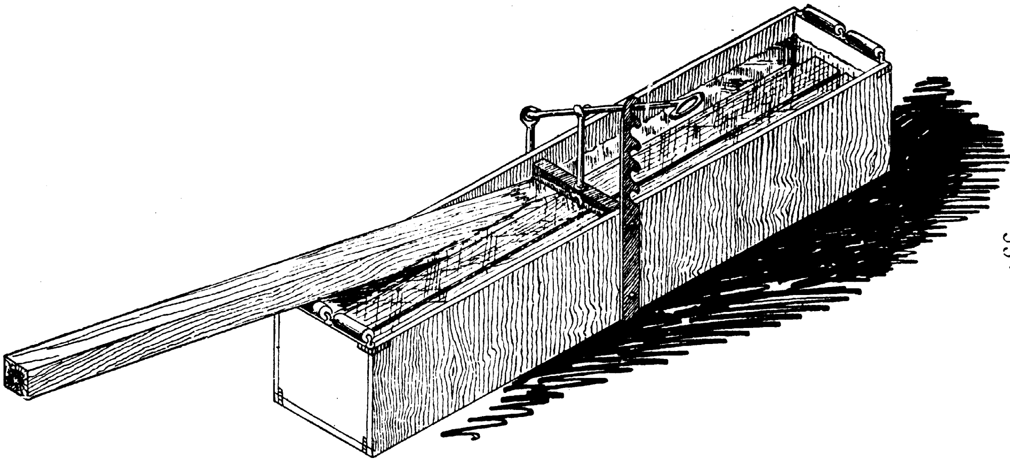
Durable timbers are so by virtue of the antiseptic properties of their sap; perishable timbers are so in consequence of their sap-forming food for the various organisms which produce decay. Prevention of decay can, therefore, only be obtained by the impregnation of perishable timbers with an antiseptic sap equivalent.

The quickest and most economical method of impregnating building timber prior to use with the required solutions, is by immersion for periods in accordance with the transverse

areas and relative densities of the timbers. The penetrative action of Atlas "A" ensures that it is carried into the timber by capillary attraction if totally immersed. Where immersion is not practicable, stacks of sawn timber can be treated in an effective manner by applying solutions with brushes, sprayers, or rose water-cans to the surfaces as the stacks are built up. It is important that timber saturated with extraneous moisture should be dried before treatment. A bath, something on the lines of the illustration shown, will be found very suitable for immersing timber in preservative solutions. This bath can be extended on the same principle to suit any dimensions of timber; and is preferable sunk in the ground for use.

The advantages of using local timber in the Colonies and Tropics is very great. Atlas "A" renders wood which is otherwise unfitted for such purposes through its perishable qualities, equal to durable timbers which have to be imported from abroad from long distances at great cost.

It is claimed that Atlas treatment protects wood from white ants, borer beetles, and all



Design for Bath (in isometrical projection) for treating Timber by Immersion.

other insects. The growth of fungus, "dry" and "wet" rot is prevented and arrested. It is also interesting to note that vermin will not remain in the immediate vicinity of Atlas-treated timber, due to the insecticidal properties of the solution. A most important factor in connection with this treatment is, that timber impregnated with the preservative resists fire action in the ratio of 4 to 1, as compared with untreated wood, and flame is prevented. A simple demonstration of the fire-resisting qualities of this treatment was made in Von Brandis Square, Johannesburg, under fire brigade supervision. The test was made on two huts of exactly similar material and construction, one of timber in ordinary condition, and the other having the roof, floor, and two sides treated with Atlas "A," the two remaining sides being covered with a "so-called" fire-proof paint. Seventeen minutes after ignition examination of the remains showed that all the Atlas-treated wood was practically intact, the floor and roof of the hut made of half-inch ceiling boards being absolutely so; and the untreated parts including the painted sides were completely destroyed.

The whole of the untreated hut was demolished except for the stout frame-work timbers.

In reporting on his efforts to rid his buildings of white ants, Mr. J. Begg, of Dahingeapar Tea Estate, Assam, gave the following interesting details of his experiments :—

"I began my experiments with Atlas 'A' during the first week of September, 1898. No. 1.—Four sets of racks for the support of leaf trays, covering an area of 600 ft. by 3 ft., and consisting of sawn timber, had been erected in one of our withering houses. I discovered that the lower floor of this house was a nest-bed of white ants which threatened to destroy this timber. I applied to it three coats of a 25 per cent, solution of Atlas 'A,' allowing each coat to dry somewhat before applying the next. A few days after I thoroughly examined all this timber, and not one white, black, or red ant could be seen anywhere. Since that date (now nine and a-half months ago) I have not seen anything near this timber, and the uprights look as fresh, sound, and new-looking as if put in yesterday. No. 2.—The white ants had severely attacked the sawn timber work, which

supported an iron roof in a coolie line. I applied three coats of Atlas 'A,' as before given in the case of the leaf houses. This was in the first week of September, 1898. Since that date not a single white ant has attempted to look at the timber, and it is as sound and fresh as when put up. No. 3.—Some pieces of ordinary unsawn timber had been left in the leaf house (No. 1). On examining these I found them swarming with white ants. I put a piece of sawn timber dressed with Atlas 'A' in the midst of these pieces, and covered the lot over with grass to the depth of about 2 ft. Two weeks after I found the untreated wood was practically consumed by the ants, while the piece I had put in the centre was absolutely intact."

Recent advices from Mr. Begg state that a quantity of the timber referred to in the above tests is still in use and in good condition.

RAT EXTERMINATION.

Both on cacao and rubber estates, the rats and other rodents, but especially rats, seem to cause trouble and expense to the unfortunate

proprietor in proportion to the prosperity of the estate and the increase in its area. Possibly this is caused by the large number of rats per acre to be found on most estates. A writer claimed in the *Field* (London) that the average rat population of this country was probably two rats per acre, or 150 millions for the United Kingdom. Whether, as the land is cleared for estate planting, the rats increase in the Tropics at the same rate, perhaps faster, I cannot say; but even if they multiply and spread at a far less rapid rate than described in the *Field*, there is no gainsaying the fact that they are an intolerable nuisance, and expense, as well as a danger, both to health and property, to every estate owner.

The Campaign against Rats.

The adjourned meeting of the new association which is to wage a war of extermination against rats was held recently at the Whitehall Rooms of the Hôtel Métropole, when Sir James Crichton-Browne took the chair and delivered an address on the subject.

"No more destructive animal existed," he

told his audience ; "nothing came amiss to its chiselling teeth and insatiable maw. It made heavy depredations on fields of corn, on stack-yards, granaries, and ship cargoes ; it devoured eggs, and killed poultry game. Worse than all, the rat took an active part in the dissemination of disease. At one time it was supposed to render good service by devouring animal and vegetable *débris*, the putrefaction of which might otherwise have been productive of evil. But it would be a sorry system of sanitation now that left any scavenger work for the rats to do. The connection of the rat with a specific disease was first made out by Zuschlag, a Danish engineer, whose studies in economic zoology satisfied him that trichinosis, a parasitic disease, was to be traced to the rat. It was by consuming trichinosed rats that pigs contracted it and so passed it on to man. Trichinosis was rare in this country. Zuschlag's discoveries had led in Denmark to the formation of a powerful society pledged to the destruction of rats, and in Germany to the issue of a rescript by the Imperial Chancellor directing the extermination of the rat in any district in which a case of trichinosis had

occurred. But there was a far worse indictment than that against the rat in relation to disease. The rat, it was now known, was mainly instrumental in the causation of plague, which had been playing frightful havoc lately in our great Indian dependency. It was in 1896 that the present epidemic appeared in India, probably brought from China, and from then up to April last year it had caused 5,250,000 deaths. In 1906 the deaths fell to 500,000; in the first four months of last year they reached the highest point on record, 642,000. The plague was not spread over all India, but concentrated in certain areas, which it had desolated and left panic stricken. Rats were peculiarly susceptible to the disease, and it was now fully established that they were the main fountain from which the disease was drawn, being conveyed to man by means of little intermediaries in the form of the flea. The flea sucked the blood of the plague-stricken rat and subsequently bit the man, planting in him the deadly *Bacillus pestis*, as surely as the vaccinator planted vaccinia in the arm he punctured. If we were to stamp out the plague we must stamp out the rat. There

should be destruction of the rat in every plague-infected district. It was certain that the limited outbreak of plague in Glasgow in 1901 was due to rats. Its extermination was a large order, considering the world-wide distribution of the animal and its prodigious fecundity. One pair would produce as many as 800 descendants within twelve months. But in limited areas, at any rate, it was not, it seemed to him, an impossibility. The fumigation of ships was of great importance, and poisons like phosphorus and arsenic under certain conditions were not to be despised. But of late there had been a new and a promising departure in the crusade against the rat. A modern St. Patrick or Pied Piper of Hamlyn had come to their aid in the shape of science, and it seemed feasible to invoke the aid of the microbe as an auxiliary in their struggle with the rat. Dr. Danysz, of the Pasteur Institute at Paris, had produced a bacteriological preparation containing, he alleged, disease germs to which only animals of the rat genus were susceptible. When the bait charged with that particular living organism or virus was eaten by these vermin, they contracted a disease

from which they died in from eight to fourteen days, and which they could communicate to other rats with which they might be brought into contact while in the diseased state. A contagious epidemic was induced in the rats in the locality in which the virus was employed, an epidemic not communicable to man, but one which ought to clear out the rats. It seemed certain that the virus, when in a fresh and active condition, did no harm to cats, dogs, fowls, or human beings, but did kill rats which had partaken of it, and so affected them that they sought air and water and open spaces, and did not die in their holes or burrows, or under floors or behind wainscots. There were several other bacteriological preparations on the market warranted to destroy rats. We had probably not yet reached the highest possible achievement in that matter. The suggestion of the Board of Agriculture that agricultural clubs should take the matter up and act simultaneously and on a large scale was an excellent suggestion, but a still better one was that the whole country should take the matter up, and that a national movement against the rat should be inaugurated."

With Sir James Crichton-Browne's view I most fully concur, and have only to add that it would be as well were the authorities, both at home and in the Tropics, to see that steps are taken to rid centres of the rats, either by individual or collective action, the same as I ask for in my Preface with regard to insect and other pests. Now that we have, as the doctor pointed out, Danysz virus, there is no excuse for the matter being neglected. In this respect, therefore, it is important to note that a start has already been made.

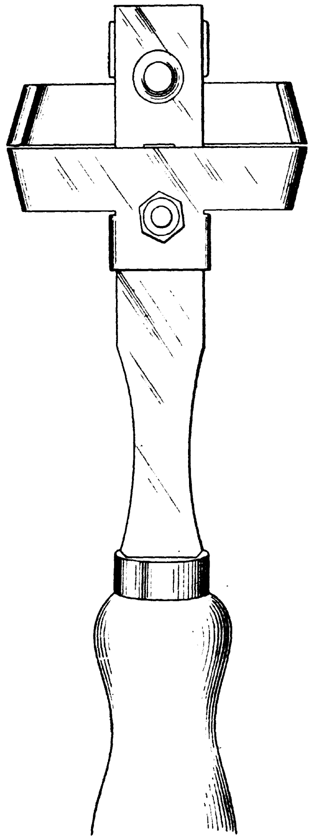
In the House of Lords on November 22, Lord Allendale, in reply to Lord Lamington. said that the Local Government Board had, in the case of the plague-infected districts of East Anglia, issued an order as to the destruction of the rats and imposing the duty on the sanitary authorities to see that this was done.

Rubber Machinery.

Having now, so to speak, caught, or rather produced, our hare, I will proceed, not to cook it, but to prepare it for market. There are many ways of doing this, some good, some

bad, and some very indifferent. I am not of course going to trouble about the last two, beyond telling you to avoid them as if they were *Fomes semitostus* or canker. Even among the methods that can safely be classified as good, we have plenty to choose from, and each firm of engineers in their turn claims, and very rightly claims, perfection for their machines so far as the individual principle is concerned, while they leave to the planter or the manufacturer to decide the lesser details, such as which kind of roller they prefer, or which method of drying and packing they feel to be best suited for their requirement.

It is necessary here, in what might be described as the "Tree to Tyre" section, to couple the planter or producer and the manufacturer together, as in the preparation of raw rubber for "making up," the degree of preparation which the rubber has received previous to its arrival at the manufacturer's warehouse varies to such an extent that the washing, crêping, and other machines are almost equally used by both parties. This is because the bulk of the shippers or collectors in Africa, Brazil, &c. (and these, after all,



THE NEW BOWMAN-NORTHWAY DOUBLE ACTION GOUGE TAPPING KNIFE.

(Recently introduced by the B.-N. Syndicate.)

are the chief exporting centres supplying from 70 to 80 per cent. of the whole) make use of no machinery at all, or did not do so until quite recently ; whilst at other centres, especially in the East, they strive to send their rubber to market perfectly pure and clean, so as to render it unnecessary for the article to be further treated before being made up. If all rubber were sent over in this state then the washing machine would only be met with on the estates, but I notice that, in spite of all the care taken on the other side in the preparation of the rubber, there is still apparently too much slackness and inattention to the packing and package, so that dirt, sawdust, splinters, &c., become attached to the rubber between the time that it leaves the washing machine on the estate and is opened out for use in the store room of the manufacturer. Until therefore planters see that their rubber is kept clean, and packed in cases that have been carefully planed, and are free from sawdust, dirt, &c., as Mr. Kelway Bamber and others have repeatedly urged them to do, it is waste of time and money to prepare their rubber so carefully, unless they are equally

particular when packing it up for export. The manufacturers do not trouble to warn them against their carelessness, but when they have to rewash the rubber because they find splinters and dirt upon it when unpacked, the next time the mark comes up for sale they remember this, and bid lower accordingly.

I was discussing this matter only a few days ago with the man in charge of a washing machine,[1] when he told me that two splinters found on the outside of a parcel of rubber might possibly cause the whole to be rewashed, as it is easier to do this than to pick it over by hand, and the firm never "ran risks." Planters therefore, if they trouble at all about sending home clean rubber, must see that this adjective is applicable to the case as well as to the contents, otherwise they might just as well save their money, and not trouble to wash and prepare their rubber as carefully as they are now doing.

Before describing the machines I want to say a word or two on the requirements of the manufacturer in the near future, both in

[1] November 18, at some rubber works in Birmingham.

regard to rubber and cacao. This is an age of "big concerns" and the elimination of the small maker, whilst the tendency for some years to come points to further concentration, rather than decentralization. The result of this is already to be seen in the marked preference for "Fine Hard" Pará in rubber, and Bahia, San Thomé, and other large producing centres for cacao. Apart from the question of quality, this preference will always be shown to such centres, because they turn out their produce to well-known, recognized, and even, types by hundreds of tons per annum. This saves the manufacturer, once he has made his contracts, any further trouble or anxiety about the supplies of his raw material; and not only is the quantity assured, but he also knows that so far as colour, make up, &c., are concerned, he will get exactly what he wants, and this is more than can be said with the bulk of the produce, rubber, or cacao, turned out by the larger estates or smaller proprietors, at other centres, where each turns out his crop according to his own ideas of what is wanted, and not to a general type in common with his neighbours.

Complaints on this point recently appeared in the *India-Rubber Journal*, but any one looking though the files of TROPICAL LIFE will see that I all along steadily discussed this point with the planters, and warned them that, if they wish to get the top price for their produce, after the novelty which has enabled them to sell their produce as a fancy article has passed off, they must turn out their cacao or rubber to type, so as to place upon the market tons instead of cwts. of a given quality so as to obtain their full share of competition by attracting the largest buyers as well as the smaller ones to their lots. Anyone who has seen a manufacturer running over the pages of his stock-book realizes the importance of this. Small mixed lots will run into several pages, although in the aggregate they will only total the twentieth, fiftieth, or even the hundredth part of as many lines of produce from the large centres, whilst the difficulty of grading, sorting, &c., according to quality, colour, resin content, tensile strength, &c., gives further trouble to the buyer, and so handicaps the mixed lots in the race for the best price.

This averaging up of produce from a common exporting centre can be done much more easily and inexpensivly to-day than was the case ten or even five years ago; furthermore, from all I can gather, the drying and preparing machinery that the leading engineers will have perfected and be able to place upon the market in the course of the next few years will so tend to facilitate and equalize the output of the produce passing through them, that by 1915 everyone will probably be wondering how it was that the producers and manufacturers could have been satisfied with the odd job lots that are now sent to market.

Take the three or four leading firms with whom I have had most to do, firms to whom I have always given the preference because they have shown greater confidence in their machines. This may sound interested because each of them at one time or other has worked with me; but that is not the reason at all, as in one case I recommended their machines without having even corresponded with the makers. I do maintain however that, if a machine is not considered by the makers worthy of being pushed by judicious adver-

tising, that is to say, if they do not feel inclined to spend money to introduce it to possible buyers, the latter cannot be blamed if they in their turn hesitate in spending their money on buying such a machine.

No one can say that a firm like Messrs. David Bridge and Co., Ltd., have not every confidence in the machines that they are daily putting upon the market, to be used by cacao and rubber planters in the Tropics or the manufacturers in Europe and America.

The medals awarded to this firm at an exhibition recently held at the Gold Coast in West Africa, or last summer at the Exposition Universelle, at Brussels, also show that others share in the confidence of the firm in the machinery they turn out. These cover the entire course of preparation, as far as rubber is concerned, from the time that the latex first makes its appearance in the outer bark of the tree in the Tropics, to the final output of the mackintosh to be worn in sunny (?) England or rubber overshoes in arctic Russia. Nothing comes amiss to this firm; when your trees are ready to be tapped they supply you with their "Huber" tapping knife, which was

acknowledged by the recent Manaos Congress as being the best tapping knife yet introduced. This knife was invented by Dr. Huber, of

THE "HUBER" TAPPING KNIFE.

THE "BI-HUBER" PERFECT ADJUSTABLE TAPPING KNIFE.

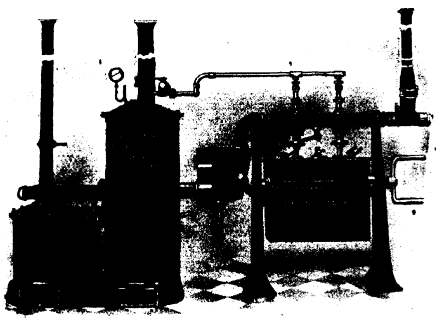
These photos show views of the single and double-handed knives, both of which will do the gouging and paring system as may be required.

Pará, and can be supplied for use either with one or both hands; it is easily adjustable and in consequence of there always being two points

in contact with the bark to facilitate its movement, *i.e.*, at the cutting blade and also at the end of the handle where a roller is provided, the handle, which is made of aluminium, can be firmly held close to the bark at any required angle and thus good tapping is assured. Having now tapped your latex, the firm supplies the necessary cups, pails, strainers, &c., necessary for transport, &c., before passing the latex into their "Da Costa" machine for coagulating and smoking the rubber, in order to turn it out with as little loss in weight as possible and of equal quality to the "Fine Hard" Pará that is exported from the Amazona Valley in thousands of tons every year. This machine promises to play an important part on rubber estates in the near future, since it answers the two requirements which dominate all others as regards the rubber machine of to-day, viz., it smokes the rubber whilst coagulating it and it turns out its rubber in bulk to "type" with such reliability that the last hundred-weight drawn from it ought to be, if the instructions are carried out, equal in every way to the first.

Taking their Da Costa coagulator first,

the coagulating and smoking by means of this plant is the simplest of all operations in the rubber industry, and may be performed by any inexperienced hand, the process being as follows :—



THE DA COSTA PATENT "RAPID" RUBBER LATEX COAGULATOR BY THE STEAMING AND SMOKING PROCESS. FOR ALL KINDS OF LATICES.

The latex, being brought from the field, is strained if it is found to contain mechanical impurities, and then poured into the coagulating tanks. Steam is meanwhile being raised to about 30 to 35 lb. in the boiler, forest woods alone being used for fuel. On to the burning wood in the furnace are then thrown green palm leaves, nuts, or any green twigs of

tropical trees, the distillation of which produces acetic acid, whilst the fumes of the green foliage will be found to contain creosote to some extent. These fumes are accumulated in a special receptacle after being cleared of cinders, &c., and they are then forced into the coagulating tanks by a steam injector.

The force of the steam violently agitates the latex, and during this operation every particle of it is reached by the smoke. In about ten minutes, or rather more if the quantities to be dealt with are very large, the caoutchouc globules coagulate and separate from the lyes and rise to the surface.

The complete installation is made in various sizes to deal with 10 to 1,000 gallons (or more) of latex at the same time. It will, therefore, be very difficult to find any other system to handle large quantities of latex in such an expeditious manner. The coagulator is thus designed for both present and future developments in the rubber-growing world, when thousands of gallons of latex will have to be treated at short notice.

The coagulated substance, after being allowed to cool off in the tanks, is imme-

diately cut up into suitable sizes and passed through the macerating, crêpeing, and sheeting machinery. Here it should be specially explained that with the Da Costa system it is not necessary to subject the newly coagulated rubber to excessive maceration, simply because

DA COSTA SMOKED RUBBER.
(1) As coagulated in bulk. (2) Crêped, vacuum dried and made into blanket form. (3) Sheeted only after coagulation.

it does not contain the strong manufactured acetic acid, which the planters in the East are so anxious to expunge by severe washing and maceration, but doing so must help to destroy the elastic properties of the rubber. Crêpeing or sheeting with the Da Costa system is only necessary for quick drying.

Rubber prepared in this way retains all the natural elements, as regards resiliency and tensile strength, of fine hard native Pará, and will, if kept in a crude state, last as long as the wild rubber, *i.e.*, for years.

It is claimed for this coagulating plant, therefore, that it not only has the advantages of dispensing with the assistance of chemical agents in a liquid form, but also allows the producer to send to the market the only preparation that satisfies all the rubber manufacturers' requirements at the various manufacturing centres throughout the world. In addition to this, the inventor claims that it also possesses the unique property of being the only apparatus which can convert the latex of the *Castilloa elastica* into a rubber of equal market value, appearance, and colour to that of the best Pará sorts exported from Brazil. As a matter of fact, the system will coagulate all kinds of latices known throughout the world.

Having given details of the Da Costa Coagulating Plant, let us now glance at the other machinery specially adapted to suit Ceylon, Malay, Borneo, African and other rubbers

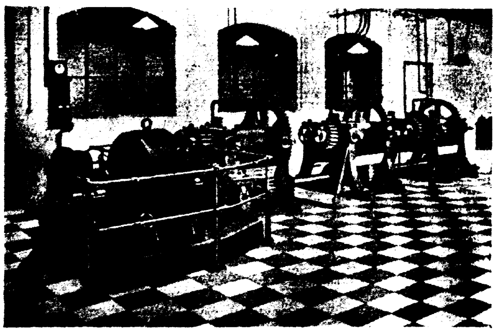
from the crudest to the most scientifically collected latex.

REGARDING RUBBER WASHING, SHEETING, CRÊPEING, DRYING, AND BLOCKING MACHINERY.

These machines constitute a most important part of the modern plantation factory. Messrs. Bridge's exceptional experience in the manufacture of this class of machinery for rubber manufacturers, planters and others enables them to put before their friends an array of machinery to suit every condition of the plantation and wild rubber trades.

They strongly recommend the adoption of the heavier machines, driven direct from the line shaft by gearing, and this line shaft driven by gearing from engine. Also, that each machine be driven by means of their Heywood and Bridge's patent friction clutch, and arranged so that each machine can be instantly stopped by means of the patent semi-automatic disengaging gear. This advice is well worth acting upon; as it gives smoother running, greater output, and a freedom from accidents, avoids trouble in belt slipping and breakages, and consequently saves loss of output.

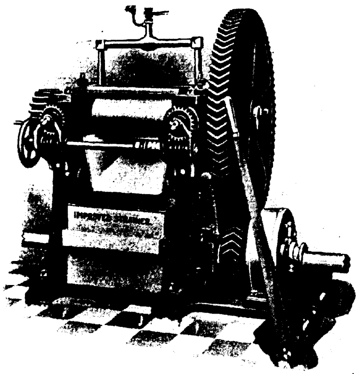
Regarding the grooving of rollers, there is a difference of opinion, but experience teaches that the diamond cutting gives every satisfaction. Where a battery of three machines is installed the first one should be rough cut; the second, medium; and the third fine.



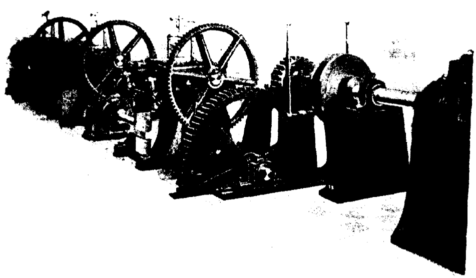
MOTOR UNDER-DRIVEN BATTERY OF BRIDGE'S IMPROVED WASHING-MACERATING, CRÊPEING AND SHEETING MACHINERY.

Three such machines, geared up as suggested, will tackle any species of African or other rubber most satisfactorily.

We illustrate a lighter but most useful size of machine which can be arranged in batteries of three, six, or more machines by



Bridge's Washing-Sheeting Machine, under-driven through Heywood and Bridge's Patent Friction Clutch.

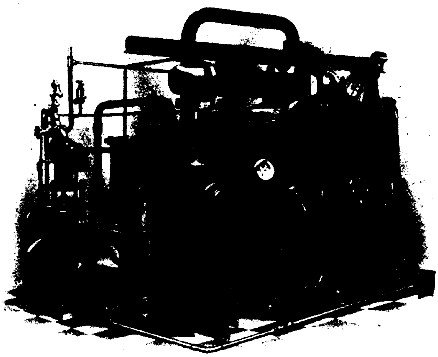


Battery of Bridge's Improved under-driven Washing-Macerating, Crêpeing and Sheeting Machinery.

These machines are under-driven, *i.e.*, driven direct from line shaft through gearing, and Heywood and Bridge's patent friction clutches from oil engine and main clutch. By the aid of these friction clutches the machines can be started up gradually (and stopped) without any shock or jar taking place—thus preventing breakdown.

simply extending the line shafting and foundations.

It will be noticed that this machine also is driven by a Heywood and Bridge's patent friction clutch, so as to preserve the gearing and enable the attendant to gradually start up the machinery from rest.



BRIDGE'S IMPROVED VACUUM DRYING PLANT.

RUBBER DRYING.

Coming to the question of drying, especially for rubber estates in the future, when large, and very large, quantities of rubber will have to be dried as speedily as possible, the vacuum-dryer stands pre-eminent.

Where care is exercised this method of drying gives entire satisfaction, and has been adopted by some of the most successful estates. It is the ideal system, especially when working in conjunction with the best machinery for washing, crêpeing, sheeting, and blocking. The sheeted rubber is either placed on shelves or racks whilst the hot air or moisture is drawn through same by a suitable vacuum pump. It is now only a question of a day or two, for the latex to be gathered, washed, sheeted, dried, re-sheeted, blocked, and sent away in a perfectly cured and high-priced condition.

In these days of mixed plantations, when the tendency is increasing to plant more than one crop, so as to distribute the risks, both financial and from fungus and insect pests, the vacuum-drying chamber specially appeals to the planter as *being the only dryer* that can equally well dry rubber, cacao, copra, &c., all products that are produced on African or any other tropical estate. At the most only a change of shelving or trays would be necessary, but not always that. Once the prime cost of the machinery has been incurred, the planter

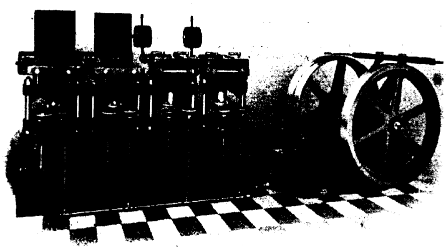
—no matter what crop he is producing—can rest quite independent of the weather, and, with experience, can turn out his produce with celerity and of good even quality.

Block Rubber.

There is a difference of opinion as to whether the rubber should be exported in block or crêpe form : there are points favourable to both, but in our opinion the block form, made up in suitable sizes, is preferable on account of the absence of oxidation, &c., &c., especially after it has been dried in a reliable Vacuum Dryer. The Ceylon Rubber Exhibition clearly proved that block rubber was a success. In the past, block rubber was in disfavour, chiefly on account of it lending itself to impurities being added. Good brands of plantation block rubber are being accepted as perfectly pure rubber and at the same time commanding the highest possible market prices. If the blocks are not too big then there is no difficulty in the rubber manufacturer accepting same, and if perfectly dry and free from all impurities the blocks can be used at once in the mixing mill. The blocks should be made

into sizes; say, 9 in. by 9. in. or 12 in. by 12 in. up to 1 in. thick.

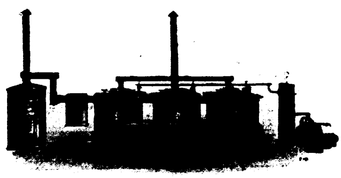
Special attention has been given to the designing of patent hand, power, and hydraulic presses, and patent interchangeable press boxes, so that one press can serve, say, a



Battery of Bridge's Patent Hydraulic Rubber Blocking Presses and Pumps.

dozen boxes; they are being steadily adopted by planters in different parts of the world. Messrs. David Bridge Co., Ltd., make a speciality of supplying installations complete in every respect, consisting of building, engine, boiler, plantation tools (tapping knives, cups, &c.), coagulating, washing, macerating, crêpeing and sheeting machinery, vacuum dryers and blocking presses.

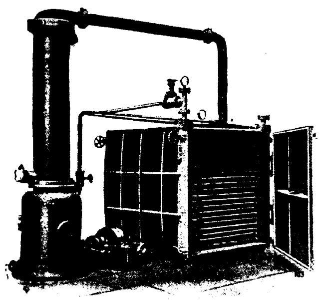
Another process for coagulating latex in bulk by the smoking process has been placed on the market by Messrs. Francis Shaw & Co., Ltd., of Manchester, and for which a provisional patent has been granted. In this case the smoke is forced through the latex by means of compressed air, a small pulley-driven air-compressor being used for this purpose. The coagulating tanks are made in units containing



THE SHAW PATENT COAGULATOR FOR SMOKING AND COAGULATING RUBBER LATEX IN BULK.

about 120 gallons of latex per charge, this being found the most convenient size for manipulating, although larger tanks up to any capacity can be adopted if desired. Each tank is jacketed to enable steam, waste gases, or other heating medium being employed to heat the latex to the desired temperature, which can easily be ascertained according to the various

latices to be treated. The top of each tank is hinged to facilitate the charging of it with latex, and for taking out the coagulated rubber, the liquid being run off at the bottom. A cast-iron grate lined with fire-brick is supplied to produce the smoke, which passes through a purifier before admission to the latex. The makers claim the following advantages for this system:—



THE SHAW VACUUM DRYING STOVE.

(1) The latex is coagulated at a fixed temperature, which can easily be ascertained, to give the best results.

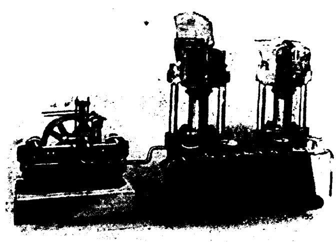
(2) Live steam at a high temperature is not brought into direct contact with the latex.

(3) The smoke is cooled by the mixture of air before entering the latex tank.

(4) The latex tanks are fixtures, and there is no handling of any part of the apparatus, the latex and coagulated rubber only being handled.

(5) Any number of tanks can be employed, and these can be of any capacity, to suit the output of the largest or the smallest estates.

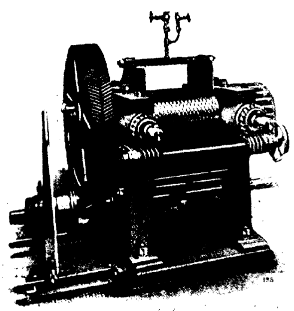
I understand that plants of this description have already been shipped to the Federated Malay States, West Africa, and Mexico, and those interested in the process are waiting with interest to see if this system will be generally adopted for producing rubber smoked during coagulation.



MESSRS. SHAW'S BLOCKING PRESSES.

On page 568 I include the plan of a rubber estate factory, showing the latest practice as regards the arrangement of the machines, buildings, &c., ample opportunity being allowed

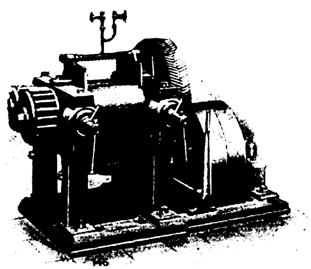
for extension as the various parts of the estate come into bearing. It will be noticed that the coagulating and machine room are contained in one building 100 ft. long by 25 ft. wide, with a verandah extending along one side. The machine shop takes up a length of 37 ft. 6 in., in which four 18-in. by 12-in. machines can be installed. These machines consist of one for washing, with deep diamond-cut rollers, two



A SHAW WASHING MACHINE, WITH DIAMOND-CUT ROLLERS.

for crêpeing with fine diamond-cut rollers, and one for sheeting with plain rollers (see next page). They are the most improved type of machine manufactured by Messrs. Francis Shaw & Co., Ltd., of Manchester, and have been adopted on most of the leading estates in

the Federated Malay States, including Linggi, Labu, Kamuning, Cicely, F.M.S. Rubber Co., Ltd., &c. The machines are driven from a high-speed line shaft running at 160 R.P.M., the back roller of the machine being driven from this shaft by a pair of double helical machine-cut gears. A Hele-Shaw Friction Clutch is adopted for operating each

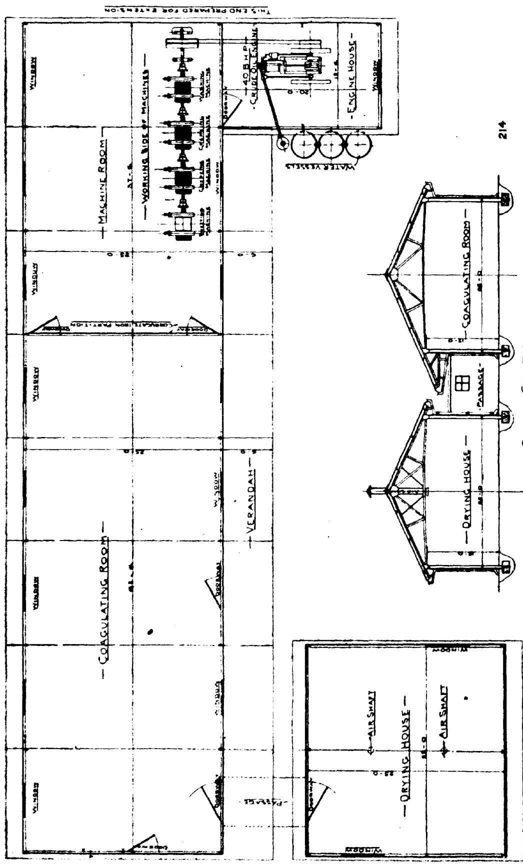


A SHAW SHEETING MACHINE, WITH SMOOTH ROLLERS.

machine, and the combination of the clutch and double helical gears renders the machines quite noiseless when working. The front roller of each machine is adjusted by setting up gear, consisting of a worm wheel operating each screw, the whole being controlled by a single hand wheel. In order to tie all the machines together to prevent the shafting getting out of

alignment, the bedplates of all machines are tied together to form one continuous bedplate. To drive these machines a 40 B.H.P. engine, driven by oil or suction gas, is usually employed, the transmission from the engines to the machines being by belting. It will be noticed that the engine is placed in a small engine house, forming an annex to the main building. When an extension is required, the end next to the machines and the engine is arranged for taking down, and for the whole plant and buildings to be duplicated. The buildings are all steel-framed and covered externally with galvanized iron sheets, with windows in each bay, and can be lined with cork insulation boards for coolness, if required. Ventilation is provided by means of expanded metal, 15 in. deep, fixed under each of the eaves. The drying house comprises a separate building connected to the main building by a covered passage; in this case it is 25 ft. square, with two ventilating shafts to maintain a continuous current of air. A cross section of the two buildings is shown with the connecting passage.

We may state that the above installation has been designed and is being erected complete



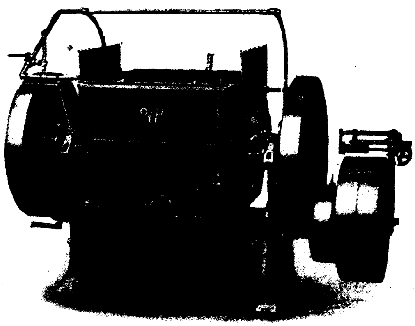
Plan of a Modern Rubber Estate Factory, showing position of the Machinery, Coagulating Room, Drying House, &c.

in the Federated Malay States for the Mount Austin Rubber Co., Ltd., by Messrs. Francis Shaw & Co., Ltd., who make a speciality of complete factories of this description, including machines, engines, and buildings.

On page 45 I spoke of utilizing the "Universal" washing and coagulating machines for preparing rubber in bulk. I wrote this from memory only, for I had not seen one of the machines in motion since the (1908) Rubber Exhibition. Through the courtesy of Mr. Kurt Pfleiderer, I have now been able to refresh my memory, and to study their latest make of machine whilst actually at work; doing so has convinced me that the idea I formed in 1908 will sooner or later become an accomplished fact, to the benefit both of the estate owner as well as of the rubber.

Except for scrap-rubber we ought in these days of enlightenment, if the latex is kept covered up, to be able to dispense with the washing machine, or reduce its use to a minimum. The rubber then would have to pass through rollers only to equalize or bulk the freshly-coagulated rubber (the same as is done at large butter centres, where lumps of butter,

of perhaps equally good quality but varying in colour, are passed through the mixers to equalize the colours) and, at the same time, to help squeeze out the water before crêpeing, sheeting or press-blocking the rubber. A machine, therefore, like the Pfleiderer mixer,



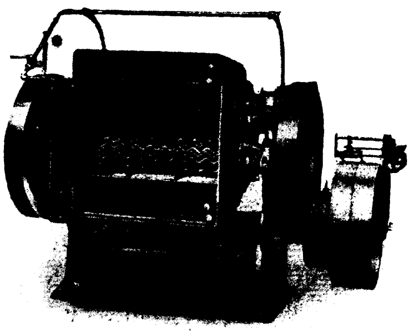
THE "UNIVERSAL" WASHER IN WORKING POSITION.

on account of its construction, could receive the latex from the tubs or tanks, as they are brought in from the fields, either by cable-way or by animals, and having coagulated it, pass it on to their washer to remove any impurities.

An ideal system for economizing both time and money would be to have a cableway erected coming from the chief centres on the estates

down to the factory, along which the large-covered tubs or tanks could be brought down to the factory filled with latex, and run straight in to the coagulating room, there brought to a standstill and automatically tilted over a particular tank, and the contents emptied therein, as is done in Trinidad (West Indies) when loading the steamers with pitch for America and Europe. The tubs would probably vary in size, to suit the machine, to hold, say, 50 or 100 gallons, so that there would then be no hesitation or fear of the latex running over when emptying the tubs; otherwise either a loss of latex would result, or waste of time to avoid overfilling. As soon as the machine had received its supply, coagulants could be added to hasten as well as to equalize the coagulation, whilst the blades or beaters at the very bottom of the machine, being revolved very slowly, would agitate the contents, and equalize the coagulation. As soon as this has taken place the trap or draining valves in the bottom would be opened and the water and leys drawn off, leaving only the soft, spongy lump of rubber. The trough of the machine would then be tilted over, and the contents

discharged down a shoot into a "Universal" washing machine on the floor below, where it would be washed and freed from all sand and impurities, and at the same time "bulked" into one even mass of fine-grade rubber, which could then be smoked, if wished, previous to being crêped, sheeted or press-blocked for shipment.



THE "UNIVERSAL" WASHER.
With trough turned over to show the interior.

This takes some time to explain, but would be very simple when put into practice, as must be done, if the estates produce the tons of rubber that we are told will be forthcoming next year or in 1913 and 1914; some such process would certainly facilitate and economize

the use of cheap hand labour, keep the latex and rubber clean, being always in covered receptacles, and equalize the bulk as far as is possible to do so, for the manufacturers.

The "Universal" washer certainly has many interesting points about it; the edges of the corrugations do *not* interlock, they do not even touch, but are about half an inch apart, which increases their ability to draw in and thoroughly knead, press, and mix up the contents of the trough without punishing the rubber. The rollers or blades take hold of the rubber, and carry it down below, where owing to the way the bottom of the machine is shaped the rubber is brought up to be again seized and worked, continuously and automatically without manual assistance; whilst excessive squeezing and tearing, which spoils the life and nerve of the rubber, is avoided. All this time the grids and strainers remove the impurities, sand, stone, wood, &c., which the peculiar action of the blades releases and brings to the surface, to be washed away over or through the strainers to the outlet below, leaving the rubber behind quite clean and intact. It is most interesting to watch this machine

remove large pieces of bark and new wood without breaking them, and of course it is a great advantage to be able to avoid splintering. The last time I had the opportunity of inspecting one of these washers at work was at a factory in England, where it was cleaning some Benin ball, the smell from which was almost intolerable, especially from the hot-water tank, where it was first well soaked before being put by the bucket-load into the washer, and thoroughly cleansed without being touched by hand. The firm using this machine did not confine itself to washing its own rubber, but also contracted with outsiders as well to wash theirs, an idea that might be taken up by estates as well as by manufacturers. Briefly stated, the advantages of the Pfleiderer " Universal " Washer seem to be as follows :—

Preservation of the "life and nerve" of the rubber owing to avoidance of excessive compression and severe treatment.

Rapid and very complete removal of all impurities, whether light or heavy.

Saving in power, due to the absence of any severe compressing action.

Automatic action after charging of machine, dispensing with constant attendance.

Greatest safety, as operatives have no need to handle the material during treatment.

Saving in space and outlay due to one "Universal" having often an output equal, in the case of the large size, to 8 or 10 ordinary washing mills.

Greater output, especially where low-grade rubbers or gutta-percha or Balata are treated.

Absence of pulverizing action on either material or impurities.

Messrs. Werner, Pfleiderer and Perkins, Ltd., will be pleased to promptly furnish further particulars of these machines regarding their output, H.P. required and results obtained, on receipt of inquiries, at their works in Peterborough (England).

Vacuum Drying for Rubber, Cacao, Copra, and other Tropical Products.

By J. Darnley Taylor.

Nowadays the question of drying is one of the most important items in the daily programme of almost every planter. When outputs were comparatively small he was able

to do the necessary drying by means of the heat of the sun, but now that demands have largely increased he has had to call science to his aid.

As in most other things pertaining to the cultivation and preparation of rubber, coprah, &c., opinion is still much divided as to whether the vacuum system of drying the crude materials is more advantageous and effective than the hot-air method; meanwhile it is interesting to note that the former is gaining in favour more and more each year, both on the plantations abroad and in the factories at home.

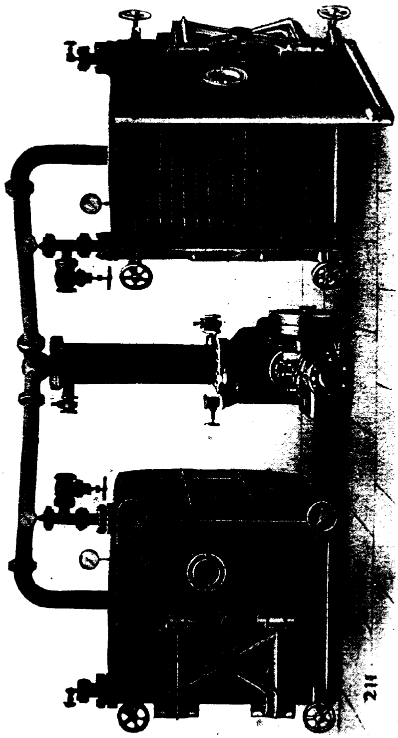
It is the habit with some planters, whether they have used vacuum dryers or not, to condemn the system. When questioned as to the ground on which they arrive at their conclusions, they reply that by its employment the rubber becomes "nerveless" and "tacky," and is, in consequence, depreciated in value. Further cross-examination as to the causes of these alleged troubles shows that when they arise they are caused by (1) excessive heating, (2) the vacuum, (3) the speed at which the drying is effected. These are not faults of the system

at all, but of the manipulator—a distinction as well as a difference.

Speakers at the Rubber Exhibition, 1908, and at Dr. Schidrowitz's lecture before the Chemical Society on April 4, also in that scientist's notes of a recent visit to Sarawak and Malaya, published in the *India Rubber Journal*, November 14, 1910, agree that under proper treatment the vacuum chamber is a distinct advantage, as it does the work required of it quickly, cheaply, and very effectively in every way; in fact, this method accomplishes the same work in as many hours as the sun takes weeks, no matter what the climatic conditions may be; whereas, in the latter case, the work is practically suspended during the rainy seasons. Moreover, it enables the same machine to be used for many products.

Provided the apparatus is well constructed and capable of attaining and maintaining a high constant vacuum of, say, 28 to 29 in. (this is essential), there is absolutely no reason why the dried rubber should be spoilt in any way if ordinary care is used.

The causes of "nervelessness" and "tackiness" in rubber are many. It may be because



THE SHAW DOUBLE VACUUM DRYING STOVE.

a wrong method has been used when coagulating, or it may be that an excessive percentage of albuminoids or resins is left in the rubber. Usually, when these troubles arise after it has been vacuum dried, it is because the rubber is allowed to remain in the chamber subjected to the heat of the shelves, with the temperature rising inside the chamber, after the superfluous moisture has been removed, and it naturally follows that a cooking or roasting action takes place, which, of course, is very detrimental to the rubber or any other produce containing volatile or aromatic properties, and naturally renders them less valuable. If, however, proper care is taken and the operator is shown when to stop, perfect results are obtained quite easily—much more quickly and economically than by any other known method. The vital questions, then, are "When should the operation be stopped?" and "What indications can the attendant be guided by?"

In the first place, it is quite unnecessary, and even harmful, to take rubber down to "bone dryness." In order to reach this degree, steam at a comparatively high pressure is required in

the heating shelves, as the last 2 to 2½ per cent. of moisture needs a much greater energy to remove it than what may be termed "loose moisture."

By the hot-air method of drying it is a practical impossibility to remove this remnant 2 to 2½ per cent. moisture (and herein lies the reason why some say there is nothing to beat the old system of drying), because the hot air itself is always charged with a small percentage of moisture: therefore I recommend all planters and manufacturers using, or intending to use, a vacuum chamber to allow this small percentage of moisture to remain in the rubber, cacao, &c., as with rubber it helps to prolong its life and to give it greater elasticity. It also pays better to do so from a selling point of view.

Modern and properly constructed vacuum dryers, fitted with all the latest improvements, offer every facility for carrying out their work speedily, at a low temperature and a minimum cost, &c., and are designed to make easy the responsibility of the operator.

The doors of the vacuum chamber are provided with inspection windows, so that the

rubber, cacao, &c., can be kept under constant observation during the drying operation. Inside this window a thermometer, with a long tail running at right angles, is fixed, so that when the door is closed this tail buries itself between the rubber sheets or cacao beans on one of the trays; by this means the differences in temperature may be observed. The first indication of the materials being sufficiently dried is when the temperature begins to rise, further corroboration being supplied by the cessation of the drops of condensed vapour falling from the bottom of the condenser into the receiver, which can be seen through windows fixed in that receptacle for the purpose. Now is the time to stop the drying operation.

Once this is realized excellent results can be obtained, for the material having been subjected to an even, constant temperature, and therefore dried in perfect uniformity, the colour of the materials will be good owing to the absence of air, which when present causes oxidization. Another advantage is that in the vacuum chamber there is no chance of contamination from impurities such as grits, sand, &c.

Taking, then, a broad view of the circumstances which attend the vacuum drying of these materials, under suitable mechanical and other conditions, it does not fairly meet the case to say that the vacuum system is inferior in its results to the hot-air process. Experience proves that it is superior, and many of the largest producers have had the vacuum principle in successful operation for a considerable time. One convincing evidence of the efficiency of this system is that the vacuum-dried rubber as exported from the Tropics obtains the best price that rules in the market.

THE DRYING OF CACAO.

Cacao, as a raw material, the same as rubber (see p. 545), will, in the future, have to be turned out "to type" to a far greater extent than has hitherto been the case. The producing centre that does not do so will be placed at a great disadvantage in competition with other producing countries. The manufacturer of to-morrow will want his raw material by the "ton," or rather by the "thousand tons," instead of by the hundredweight as at present.

On this account, both Mr. John W. Gordon and myself have for a good many years past been carrying out experiments in order to place upon the market what we each believe to be the best mechanical dryer for cacao. Mr. Gordon claims for his machine (which is illustrated in our advertisement pages) that it is the only system which will treat cacao on a large scale. The largest size of his machine will take a charge of 10,000 lb. of wet cacao straight from the fermenting vats, and dry it in from twenty-four to thirty hours. The principal features are that the beans are kept gently rolling during the whole operation, and this produces a polished and attractive appearance on the exterior shells, and the air is heated by exhaust steam. Uniform drying is obtained by this motion combined with the method of heating the air.

During the whole season a definite quantity of air at a definite temperature is employed, thereby producing uniform results. In this system the air cannot be heated beyond the degree decided upon by the manager, however careless the attendants may be, and there is thus no risk of burning or over-drying the beans.

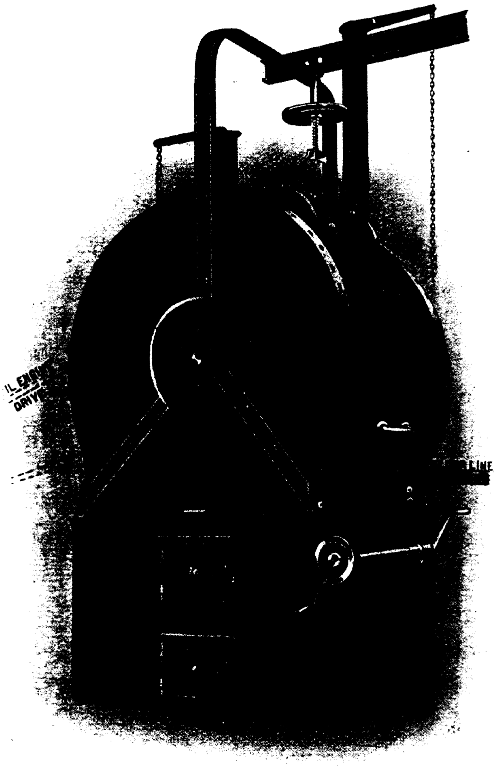
This system was adopted by the West-afrikanische Pflanzungs-Gesellschaft "Victoria" in the Cameroons, who installed six machines in one building, capable of drying collectively a charge of 27 tons of wet cacao per day. This is the largest installation in the world.

It has also been largely adopted in Jamaica, Grenada and Surinam.

Coming now to my own machine, made by Messrs. David Bridge & Co., Ltd., Castleton, Manchester, we have arranged it as shown, to get the utmost drying capacity of any machine on the market, with the greatest economy of fuel and the minimum of risk of scorching the beans. The machine has been favourably noticed in the leading works[1] on drying and cacao production, so I hope that it will materially help the planters in Bahia, West Coast of Africa, San Domingo, and elsewhere, to get over their difficulty in drying their beans and making them as attractive as possible for the market.

---

[1] See "Drying Machinery and Practice," by Marlow (Crosby Lockwood & Co.); also Mr. Hinchley Hart's new work on "Cacao," to be published shortly; and the W. I. Committee Circular, February 1, p. 55.



THE "HAMEL SMITH" PATENT ROTARY DRYER.

Several alterations and improvements have been introduced, and the capacity largely increased to suit the wishes and requirements of the big planters and others interested in it, not only for cacao, but for coprah and coffee, maize, ground-nuts (*Arachis hypogœa*), &c., as well.

In order to economize every inch of space available within the drum, the largest dryers, (see illustration on p. 585), are now made with six large cylinders instead of the twelve smaller ones as was shown in the 1907 design. Sectional drawings show that each cylinder contains three sloping ledges or narrow shelves which check the fall of the beans, and by dropping them gently towards the next ledge allow the moisture to escape and the air to circulate freely through the beans. The cylinders, thanks to the lifting arrangement and runners that we have introduced, can now be made up to any capacity, though we do not recommend a greater diameter than 2 ft. 6 in., or at the most 3 ft, for though the drum containing the cylinder revolves very slowly (only just fast enough to avoid scorching) a larger circumference would

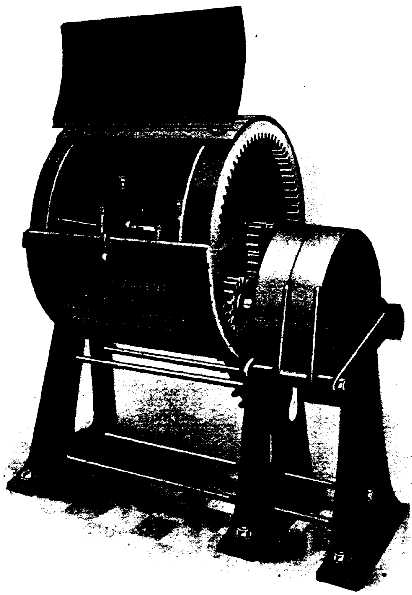
give too long a drop for the beans, and would also cause too heavy a bulk to be falling over those below, and tend to crush and damage them, especially at first when the skin or shell is soft and delicate. On the other hand, the cylinders can be made any length, so that the six cylinders will hold 10,000 lb. wet cacao, to turn out about half that quantity when dry. Opinions, even of the experts, vary considerably as to what space should be allowed per 1,000 lb. of wet cacao to be dried, and whether the cylinders can be two-thirds or only half full. No two enquiries agree on these points either as regards cacao, coffee, or coprah. We therefore suggest that all those interested in the machine, and wishing to have particulars as to price, &c., must state what space they wish to be allowed per 100 or 1,000 lb. wet cacao to be dried at a time, and must make allowance themselves when they receive the dryer as to how they will charge the cylinders. In a word, they must say what size cylinders they desire, for since ideas differ so much on the point we cannot undertake to satisfy everyone.

The motive power can be supplied by hand

in the case of the smaller machines; and by means of steam, gas, or oil engine, or with bullock, electric or windmill power with the large ones. The gear is so regulated that the drum cannot be turned so fast as to crack and break the beans. Quotations supplied so far have ranged up to a 10,000-lb. capacity dryer. As a rule we would advise buyers connected with large estates to take two machines, each to hold 5,000-lb. wet cacao, rather than one machine with 10,000-lb. capacity. The reasons for this are obvious: you can work the two easier in many ways. When the crop is small economy is assured by working only the one smaller machine, instead of the big one which consumes more fuel. Again, in case of a hitch in the machine, having two dryers on the premises instead of only one, the work is not brought to a standstill until the trouble is surmounted. When buyers are able to build their own stoves, and many seem able to do so, the drum and cylinders only, but including the damper, &c., can be ordered, at a considerable saving in the first cost, as well as for packing, freight and transport.

For those who wish to polish their beans

after drying (and many planters, seeing the excellent prices realized by good, red, polished Grenadas, Trinidads, and other growths, like



BARNARD'S PATENT CACAO-POLISHING MACHINE.

to do so), the "Barnard Cacao Polishing Machine," also made by Messrs. David Bridge and Company, Ltd., from designs supplied by

a leading West Indian planter, will be found both useful and efficacious. Simply made, the machine does not easily get out of order, and costs little or nothing for wear and tear. As regards the beans, Messrs. Bridge claim that these are not broken or cracked in the process, which renders their outward appearance even and attractive.

The machine consists of a suitably designed cylinder revolving around a central spindle. This spindle is fitted with eccentrics having rubber pads. The cacao to be polished is put into the cylinder, which is revolved by any mechanical means through belt pulleys, or by hand, and revolves in the opposite direction to the central spindle, the eccentrics moving up and down, therefore polishing the cacao in the bottom of the revolving drum. The whole machine is suitably mounted upon cast-iron stands, and is self-contained throughout. A quick-jointed door is arranged on the revolving cylinder for easy recharging and emptying same.

TAPPING KNIVES AND ESTATE SUPPLIES.

From all that I can gather from those who supply the cups, the demand for earthenware and glass cups bids fair to outstrip, if not to leave behind altogether, those made of metal; at any rate, one of the large suppliers at Birmingham, who sells cups of every description, from the little tin *tichuela* that goes in its tens of thousands to Brazil (as many as thirty to forty being used on a single tree) up to quite large glass basin-looking receptacles, tells me so. The cups are purposely made with a lemon-shaped bottom like a soda water bottle in order to prevent the natives from "borrowing" them to use for household requisites, which they were able to do, and did do, when the cups had a flat or ordinary rounded base.

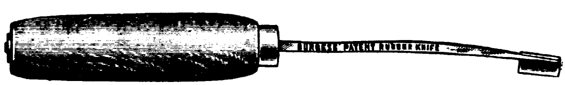
The reason of this marked preference for non-metallic receptacles to receive and hold the latex is perfectly obvious to anyone who has seen a rubber cup after its first day's service. The moisture, both from the latex as

well as from the little water itself that was probably placed in each cup, before attaching it to the tree, causes such a degree of rust to cover the interior that even the most thoughtless or uneducated native would probably demur at using such a cup a second time. Well-tinned and well-leaded metal, of course, would not deteriorate so rapidly, but the severe competition between (1) manufacturers or factors where the cups are made, (2) merchants, store-keepers, and traders at the producing centres where the cups are used, has caused the prices for these most necessary articles to be reduced and cut to such a degree that the quality has become unreliable owing to the protective covering often being insufficient to keep the moisture from the iron; hence universal rust is spread wherever the latex or water touches the sides; this is, of course, just the place that the manager on the estate is anxious to keep as clean and free from rust as possible. Until, therefore, the actual users can arrange between themselves to pay prices sufficiently high to ensure their having well-coated cups, one is not surprised to see them turn to those made of glass or earthenware. These, if liable

to breakage, can at least be used day after day, and week after week, without spoiling the latex by discolouring it with rust or other harmful matter, so long as they remain whole. Aluminium cups have also been tried on account of not being liable to rust, but even with this metal it was found that little black spots, which one felt anxious to prevent from coming into contact with the latex, soon made their appearance inside the cups. The softness of the metal causing it to be necessary to thicken the sides also gave trouble when it came to attaching the cups to the tree. For all these reasons, therefore, the planters, I suppose, are giving the glass cups a trial, as the solidity of their make and the comparative lowness of their cost, may possibly in the end more than compensate for their liability to fracture; and after all, perhaps, it is less aggravating to have to throw away a cup because it is broken and useless than to dispense with the use of one which is perfectly sound but too rusty to be used. Perhaps, also, if the estate should run short of cups, or an individual tapper loses or sells those given out to him to use, there might be a

danger of the rusty ones from the scrap-heap being pressed into the service, to the great detriment of the bulk when the rubber comes to be shipped.

Messrs. John Yates and Co., Ltd., of Birmingham, have made a special study of latex cups and drip-tins for rubber estates. This firm is, of course, well known as being the makers of the "Burgess Patent Rubber



THE "BURGESS" PATENT RUBBER TAPPING KNIFE.

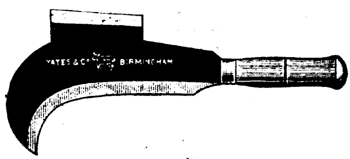
Knife," which can be obtained, handled in the usual manner as well as made to shut up like a clasp-knife, and provided with a loop at the end for the manager or others to attach them to their belt and carry with them when making the round of the estates.

The "Burgess tapper" is by no means the only one made by this firm. Their "Veteran" knife is almost equally well known, and when I visited their works to discuss the question of tapping with Mr. Ernest Yates, that gentleman showed me long rows of different patterns of

tappers of all shapes and sizes made to suit the requirements of the various rubber-producing centres to which his firm have been in the habit of shipping ever since rubber tappers were made in this country.

Taking these as a whole, I noticed that the principle of the farrier-gouge knife predominated in almost every instance; actual gouges of different sizes were, as a matter of fact, also ordered to a considerable degree, provided either with a straight blade as used by carpenters, or with a bend or shoulder to enable the tapper to "hug" his bark with the minimum risk of damaging the cambium. The "Burgess knife," as can be seen by the illustration on page 594, is made on lines very similar to that used by farriers, whilst their "Veteran knife" is also made on somewhat similar lines, so as to remove the minimum of bark whilst leaving a canal-shaped cut to keep the latex within bounds until it reaches the perpendicular or centre cut and runs down into the cup. At first sight I felt that such a shaped tool must give the user a considerable amount of trouble to sharpen, for, be it remembered, no one, who has the slightest regard for his trees, should

ever allow a dull tool tc be used. The sharpening hone made by Messrs. Yates for their "Burgess" knife does away with the difficulty of keeping this, or similar-shaped tools, as sharp as when they first leave the factory. Their "Jebong" knife is a go-between a coffee-pruner and a farrier's knife; it looks, in fact, as if the beak of the coffee-pruner had simply been turned back and sharpened. Maybe in the original pattern this was so



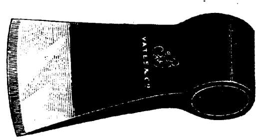
DOUBLE-BACKED BILL-HOOK FOR CLEARING BUSH, &C.

as I noticed they can be supplied with a sharp edge down to the handle, so that they can be used as a pruning as well as a tapping-knife.

Having now supplied you with the cups and tapping knives necessary to collect your latex, this enterprising firm also provides the enamelled pails with covers and sieves into which the cups are emptied by the rubber collectors, as well as the wheeled tanks, pro-

vided with covers, to be drawn either by labourers or by animals, into which the pails are in their turn emptied, until the tank being full, is sent down to the factory for its contents to be coagulated and prepared for export.

Of general estate supplies, Messrs. John Yates and Co. are manufacturers of every description of tool for the making and maintenance of plantations. For felling the trees growing on the land to be cleared, their Round



FELLING-AXE FOR CLEARING LAND.

Eye Felling Axe has been introduced, whilst for those who prefer a wedge-axe they have their "Bull," "Horse," and other makes. For hatchets "to trim" the branches previous to burning off, they recommend their "Fantail" or "Wedge" pattern, whilst their shingling hatchets come in very useful for many purposes. For "brushing" and cutting back the bush where cutlasses are used, the firm supplies

By courtesy of the Potash Syndicate.

COCO-NUT CULTIVATION IN CEYLON.

Showing Hoes in use for applying fertilizers to Coco-nut palms.

these implements known in some centres as "dhaws" and others as "machetes." The English billhooks, either double-back or single-back, are also ordered by some, the Assam dhaw being a light modification of the single-back billhook.

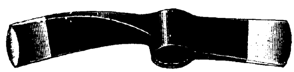
After clearing the land and burning it off, trenching forks, hoes, &c., are requisitioned to break up the ground for planting, as until the stumps are removed ploughing and systematic cultivation are not possible. Messrs. Yates's trenching and kodally forks are made for this purpose in a variety of shapes, the number of prongs also varying from two to four, according to the work to be done. Diamond-fronted, oval, square, diamond-toed, or flat-shaped, &c., prongs are sent, according to the requirements of the producing centres. When discussing this question *i.e.*, individual tastes as regards estate supplies, Messrs. Yates told me that they certainly vary enormously, but their firm is always pleased to entertain any reasonable proposals for introducing a modified or fresh design, if it can be shown to their satisfaction that such a tool is really needed and likely to command fair orders.

Coming to cast-steel spades and forks, planting bars, &c., which are, of course, too well known to need describing here, their patterns also vary considerably. Yates's "Darjeeling Fork" is made with diamond or flat prongs for tea or rubber lands in the East, and their "Darjeeling Unbreakable," considered by some to be "the planters' ideal," have short handles and toughened 13½ in. prongs to avoid breakage, as the forks have been specially designed for hard work.

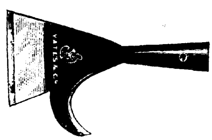
PLANTING BAR.

The cutlass or other unsuitable implement is far too often employed for planting out; this ought not to be. The transplanting of seedlings and young trees cannot be too carefully done, and planting out or transplanting tools or spades should be used as making the most suitable hole in the quickest time possible. If planters, before laying in their "supplies," would sometimes take the trouble to study the list of a well-equipped maker or store-keeper, they would often save, not only

time and money, but plants as well. Planting-out spades are mostly ordered curved, as round holes are generally required, and these tools should be more often met with, as they greatly facilitate hole-digging for planting. If a square hole is needed, Messrs. Yates supply a flat planting tool, but as a rule they are asked



AXE-ENDED MATTOCK.
A useful tool for clearing land of bush, &c.



CACAO PRUNER OR REAPER.
This is the Trinidad, &c., pattern, with hook. The Guayaquil pattern has no hook. The cutting-edge at the top is slightly concave, instead of being straight across.

for curved. Another implement that often proves very useful, especially in clearing the ground of old weeds, roots, &c., are mattocks, made in several shapes for estate work, but especially two, viz., Yates's "axe-ended mattock," with one cutting and one pick end, and their round-eye axe-ended mattock, with a cut-

ting edge at both ends (one flat like an adze, the other on end like a hatchet or "machadine").

With the land cleared, and the cacao or rubber trees in bearing, the same firm supplies the light rails and tanks or skips for transporting the produce to the factories to be prepared for market, as well as the pruning-knives to trim the trees, or the "cacao-pruners," or reapers to cut down the pods with. Both for cacao and rubber planting, therefore, this firm supplies all the tools and implements required from start to finish, *i.e.*, from clearing the land to collecting the crops.

Meanwhile, to those about to plant up an estate, the following table, which appeared recently in the *Planter's Chronicle* of Bangalore, will be found extremely useful :—

Feet apart	Give Plants to the Acre.
2 ft. × 4 ft.	5,445
2 ,, 5 ,, ...	4,356
3 ,, 4 ,, ...	3,630
3 ,, 5 ,, ...	2,904
3 ,, 6 ,, ...	2,420
4 ,, 5 ,, ...	2,178
4 ,, 6 ,, ...	1,815
6 ,, 6 ,, ...	1,210
6 ,, 8 ,, ...	907

Feet apart					Give Plants to the Acre.
8 ft. × 8 ft.	...	...	...	...	680
8 ,, 9 ,,	...	...	...	...	605
8 ,, 10 ,,	...	...	...	...	544
9 ,, 9 ,,	...	...	...	...	537
9 ,, 10 ,,	...	...	...	...	484
9 ,, 12 ,,	...	...	...	...	403
10 ,, 10 ,,	...	...	...	...	435
10 ,, 12 ,,	...	...	...	...	363
12 ,, 12 ,,	...	...	...	...	302
12 ,, 16 ,,	...	...	...	...	227
12 ,, 18 ,,	...	...	...	...	201
15 ,, 15 ,,	...	...	...	...	193
16 ,, 16 ,,	...	...	...	...	170
18 ,, 18 ,,	...	...	...	...	134
18 ,, 24 ,,	...	...	...	...	100
20 ,, 20 ,,	...	...	...	...	108
20 ,, 24 ,,	...	...	...	..	90
20 ,, 30 ,,	...	...	...	...	72
24 ,, 24 ,,	...	...	...	...	75
24 ,, 30 ,,	...	...	...	...	60
30 ,, 30 ,,	...	...	...	...	48
30 ,, 36 ,,	...	...	...	...	40
30 ,, 42 ,,	...	...	...	...	34
36 ,, 36 ,,	...	...	...	...	33
40 ,, 40 ,,	...	...	...	...	27

INDEX.

ACIDITY in Peat Soil, and its Cure, 33
Acridium (Grasshoppers) and Rubber Trees, 350
Africa, British East, Ceará yields, 446, 448, 455
,, ,, ,, ,, cost of collection, 446, 448 455
,, ,, ,, Mr. H. Powel on Ceará in, 458
,, German East, and Ceará yields, 459
African Lakes Corporation, Ltd., and Ceará, 450
African Rubbers *v.* "Fine Hard," 487
Agricultural News, The, on Pest Extermination, 252, 253
L'Agronomie tropicale on Green Manuring, 143
Air and Light Check Pests, 183
Angsana Trees (*Pterocarpus indicus*) killed by disease, 169
Anopheles mosquitoes, 43
Anstead, Mr. Rudolph, 30, 73-80
,, ,, ,, on the Cacao Beetle, 255
,, ,, ,, on Green Manuring, 141
,, ,, ,, on Inoculation, 174
,, ,, ,, on Mulching, 145
Antigua, Eleven Green Manures for, 151-159
Artificial Manures: Advantages on Rubber Trees, 129
Astycus lateralis, a Rubber Weevil, 347

BABRICOU Bean (*? Canavalia obtusifolia*) as a Green Manure, 156
Bacteria: Green Manuring and Fertilizing, 160
Bahamas, The Ceará Rubber in, 430
Bahia, Cacao Epidemic in, 4
,, If Disease broke out in, 220
,, Cacao and Die-back (*Diplodia cacaoicola*), 4, 246
,, *M. dichotoma* in, 246
Ballou, Professor, recommends Carbon Bisulphide for Borers, 238
Bamber, Mr. Kelway, advocates Green Manuring, 142
,, ,, ,, on Ceará, 427
,, ,, ,, on tapping Ceará, 476
Bananas, 7
,, as a Catch Crop, 363
Barbuda Beans as Green Manure, 152

Barrett, Mr. O. W., 7, 16
,, ,, ,, on Cowpeas as Green Manure, 146
,, ,, ,, on "Danger Signals," 17
,, ,, ,, on Stem-canker, 210
Basic Slag for *Fomes semitostus*, 344
,, ,, on Jamaica Cacao Estates, 1
,, ,, and Potash for Cacao in Mountain land, 92
,, ,, for Root Disease, 214
Bayeux Cacao Estate, Hayti, and Grafted Cacao, 275
Belts, Crops planted in, 11
,, Danger of Jungle, 15
,, Plan of Mixed Crops, 14
Benefits of inoculated Green Manure, 148, 149
Black Blight in Grenada, 174
,, Rot (*P. omnivora*), 199
,, ,, attacks trees other than Cacao, 199
,, ,, in Cacao reduces weight of Beans, 199
,, ,, (*P. omnivora*): How to distinguish it, 200
,, ,, ,, Spraying as a Prevention against, 201
Blantyre (Nyasaland) and Ceará Rubber Yields, 309
Bokhara Clover as Green Manure, 158
Bolivia, The Cost of Rubber from, 414
,, and Gutta-percha, *F. elastica*, and Vine Rubber, 408
,, Smoking Rubber in, 410-412
,, Tapping Rubber in, 405
,, The Temperature of, 408
Bones, their Phosphate and Nitrogen Value, 166
Bordeaux Mixture, How to make, 242
,, ,, How to test its Copper Contents, 243
,, ,, The Question of its Strength, 253
Borneo, Ploughing and Stump-pulling in, 84
,, Root disease, and its Cure, 84
Botryo-diplodia elasticæ, 16
,, *theobromæ* on West Coast Africa, 229
Bowman-Northway Knife in Bolivia, The, 412
,, ,, for Castilloa, The, 313
,, ,, and Ceará, The, 438
,, ,, in Nyasaland, The, 451
Bradford, Mr. Q. Q. (Hawaii), 35, 36
Branch, Mr. Geo. F., on Cacao Beetles in Grenada, 263
,, Rev. G. W. (Grenada), System of Manuring Cacao, 104
Brazil best for Scientific Study of Tapping and Tree-pests, 375

Brazil, Why it will always be an Exporter of Rubber, 486
British Guiana, Agricultural work in, 10
,, Cacao yields in, 10
,, Green Manuring in, 143
,, Hevea Rubber in, 141
Brown Rot, *see* Black Rot or *P. omnivora*
Budding Cacao, *see* Grafting Cacao
,, ,, in Jamaica: How it is done, 280
Bult (The Messrs.), on the Treatment of Tropical Plants, 177
Burning Trees for Root, &c., Disease, 78

CACAO, Advantages of Mulching, 124, 125
,, affected by Deforestation, 65, 66
,, Beetle, 255
,, Beetles and Bread-nut Baits, 258
,, ,, their Destruction, 256
,, ,, in Grenada, Mr. Geo. F. Branch on, 263
,, ,, Mr. Malins-Smith's dressing for, 256
,, ,, Reduction by Collecting, 257
,, ,, how Treated in Surinam, 259, 260
,, ,, how Treated in West Africa, 260
,, Benefits of Manuring, 94
,, ,, of Nitrogenous Manures, 106
,, Canker on Grafted, 244
,, Close-planting and Pruning, 227
,, ,, in Trinidad, 227
,, Complete Manure for, 87
,, and Cotton in Grenada, 7
,, ,, in Trinidad, 7
,, ,, in Tobago, 7
,, Crops in Grenada, 105
,, Cultivation and Fertilization of, Professor Hendricksen (Cuba) on, 122
,, and White Ants, 225
,, Diseases and Pests, 199
,, in Dominica: Table of Manurial Results, 125
,, Exports from Gold Coast, 231, 233
,, Fine quality from Selected Seed, 266
,, Gains by Reducing Shade, 10
,, Grafting, *see* Grafting Cacao
,, ,, and Budding *v.* Seed Selection, 264
,, in Hayti, Mr. A. E. Casse on Grafting, 275-283

Cacao, How to Bud the Trees, 280
,, Improvement by Selection, 292
,, Large Yields at the Gold Coast, 237
,, Manuring, 87
,, ,, Rev. Branch's (Grenada) System, 104
,, ,, in Dominica, Mr. Joseph Jones on, 124
,, ,, Dr. Francis Watts, 124
,, ,, Good System in Grenada, 91
,, ,, Professor Hendricksen (Cuba) on, 116-127
,, Manures, Results of Three Typical Systems, 95, 96
,, and Nitrate Dressing, 87
,, Pests, Die-back and Thrips, 247
,, ,, Dr. Francis Watts on, 101
,, Planting, Hygiene in, 97
,, Pod Disease. Is it *Diplodia cacaoicola ?* 202
,, ,, ,, What is it? 202
,, Pods attract Beetles, 259
,, ,, danger of leaving about, 92
,, ,, are great breeders of Disease and Pests, 248
,, ,, A Manure Compost of, 93
,, ,, Utility as a Manure, 93
,, probably produced cheapest at the Gold Coast, 234
,, Profits in Grenada from use of Manures, 103
,, Progress after Budding, 282
,, Pruning of, 9
,, ,, J. Hinchley Hart on, 107
,, ,, and Parasites in, 183
,, The Question of Cross-breeding, 294
,, ,, Seed Selection, 264
,, The removal of shade in, 9
,, Is red Forastero less liable to disease than the yellow? 194
,, Roots Culture: Rev. Branch's (Grenada) System, 105
,, and Rubber: Extremes in prices, 26
,, ,, How to plant, 14
,, Seed selection *v.* Grafting in Haiti, 276
,, ,, not as good as Budding or Grafting, 268
,, Shade and Pests, 7
,, ,, The removal of, 9
,, Stockdale on Advantages of Spraying, 249
,, Trees, loss through wound fungi, 254
,, *T. pentagona*, 195
,, yields in British Guiana, 10

Cacao, yield of Grafted or Budded Trees, 283
,, yields (per tree) in Trinidad, Grenada, St. Lucia, Cuba, San Domingo, 122
Calonectria bahiensis on Cacao Stems, 203
,, *cremea* on Cacao Pods, 203
,, *flavida* : is it Stem Disease ? 202
,, ,, and *T. pentagona*, 245
Canavalia, 21
,, as Green Manure in West Indies, 151
Canker in Cacao, Imperfect Knowledge of, 202
,, on Grafted Cacao, 245
,, cured by Sulphate of Iron wash, 251
,, Mr. Malins-Smith on, 204
,, worse near Deep Shade, 250
Caravonica Cotton, 5
,, ,, attacked by Black Rot (*P. omnivora*), 199
,, ,, and Coco-nuts, 5
Carbon Bisulphide and Tree Borers, 238
Cardoso, Augusto, on Ceará Planting, 464
Carolina, Effect of no Trees in, 59
Carmody, Professor, 4, 5
Carruthers, The late Mr. J. B., 50
,, ,, ,, on Cover-crops for Ceará, 449
,, ,, ,, on Prickers for Castilloa, 313
,, ,, ,, on Protective Belts, 57
,, ,, ,, and Spraying Machines, 353
,, ,, ,, on Tapping in West Indies, 323-324
Casse, Mr. A. E., on Castilloa in Hayti, 370
,, ,, grafting Cacao in Hayti, 275-285
,, ,, Funtumia in Hayti, 331
Castilloa Rubber, 359
,, Best months to Tap, 392
,, Clean Weeding *v.* Sylvan Culture, 382
,, Distance apart and Catch Crops, 363
,, *v.* Funtumia regarding Pests, 331
,, Its Full Permanent Yield, 395
,, and Nitrate of Soda, 35, 41
,, Planting out, 366
,, Preparation in Tehuantepec, 384
The Question of Moisture in, 386
,, ,, ,, Shade, 362
,, ,, Situation, 361, 398

Castilloa, the Question of Young Trees, 390
,, Rubber on the Gold Coast, 300
,, Reasons for Small Yields, 368
,, Seeds and Planting, 365, 380
,, Tapping into the Cambium, 390
,, ,, Mr. Cradwick and B-N Knife, 313
,, ,, De Valda on, 371
,, ,, in Hayti, 370
,, ,, in Nicaragua, 392
,, ,, in Tehuantepec, 383
,, ,, and Prickers, 313
,, Tapping and Yields, 368
,, Thinning out, 367
,, The Various Species, 361
,, What Age to Tap? 396
,, Yields in Costa Rica, 396
,, Yields, Mr. John Parkin on, 373
Catch Crops and Castilloa, 363
Ceará (*M. glaziovii*), The Cultivation of, 417
,, Advantages of Intense Culture, 448
,, ,, Manuring, 448
,, ,, Seed Selection, 448
,, Analysis of, 430
,, in the Bahamas, 430
,, in British East Africa: Cuttings *v.* Seedlings, 458
,, in Ceylon, 472
,, compared to Hevea and Funtumia Rubber, 297
,, The Cost in British East Africa, 446, 448, 455
,, Cuttings from Good Milkers to Improve Yield, 443
,, does well in West Nyasa, 309
,, Educating for Milk-production, 437
,, the Flow of the Latex, 439, 442
,, Formation of Bark, 433, 451
,, on the Gold Coast, 300
,, Green Manuring and Wide Planting, 449
,, in Hawaii, 426, 432
,, *v.* Hevea in Ceylon, 427
,, How to Secure the Best Returns, 418
,, and Irrigation, 468
,, Mr. Kelway Bamber's Opinion, 427
,, in the *Kew Bulletin*, 417
,, Less Liable to Pests than other Rubbers, 418

Ceará, Methods of Propagation, 417
,, and Mulching, 142
,, The new Multiple Tapper, 420, 437
,, The Nature of its Tubers, 432
,, in Nicaragua, 426
,, and Nitrate of Soda, 35
,, in Nyasaland, 449
,, Profit from Catch Crops, 475
,, Puncture-tapping in South India, 456
,, The Question of Tapping, 437
,, Rapidity of Growth, 431, 436
,, in Rhodesia, 470
,, in San Thomé, 430
,, Seed Germination, 469
,, Seeds and Planting, 463
,, in Southern India, 455, 461
,, Sow Cover Crops by Dibbling, 450
,, Tapping: the Atmosphere and the Flow, 439
,, ,, the best Method, 443, 448, 450, 451, 454, 456, 460
,, ,, Best Time to Tap, 439
,, ,, Canvas Water-bags to Stimulate Flow, 442
,, ,, at Entebbe (Uganda), 459
,, ,, in Hawaii, 36
,, ,, in Java, 443
,, ,, The Length of Intervals Between, 441
,, ,, Wound Healing, 442, 451
,, Trees cease Yielding at Ten Years, 459
,, Tubers and Yields, 443, 473
,, Useful in otherwise Waste Lands, 418, 419
,, Yields, 434, 436, 441, 446, 448, 454, 458, 459, 460
,, ,, in Africa and Hawaii, 373, 374
,, Yield at Blantyre (Nyasaland), 309
,, Yields in Ceylon and Hawaii compared, 428
,, ,, Hawaii, 37
,, ,, Nyasaland, 462, 463
,, ,, South India, full details, 461, 462
,, in Zanzibar, 428
,, Yield at Zomba (Nyasaland), 309
Cedar as Protective Belts, 51
Ceylon and Ceará, 472
Ceylon's Example to Agriculturists, 13
Ceylon: Hevea *v.* Ceará, 427

Ceylon, How Green Manure affects Soil Erosion, 162
,, Results of Green Manuring in, 162
Chicory as Green Manure, 155
Chisei for Stem-canker, The, 211
Clay Soils on Cacao Estates: Benefits of Lime, 89
Clean Weeding and Castilloa, 382
,, ,, *v.* Green Manuring (Cover Crops), 164
Close-planting on the Gold Coast, 180
,, in Mexico, 375
Cochin-China adopts Stump-pulling, 73
Coco-nuts and Caravonica Cotton, 5
,, The Price of, 26
,, as Windbelts, 50, 51
Collins, Mr. Jas., on Tapping Castilloa, 392
Colonial Office Committee on Pests, 198
Colorado Beetle, 182
Colletotrichum incarnatum on Cacao Bark, 203
,, ,, ,, Pods, 203
Complete Manures for Rubber Trees, 42
Compost Tanks or Pits, 20
Contagious (Plant) Disease Act, A, 344
Contour Drains to avoid Soil Erosion, 59
Costa-Rica, Castilloa Yields in, 396
Cost of Stump-pulling, 80
Cotton as Belts between Cacao, 6
,, and Cacao in Grenada, 7
,, ,, in Tobago, 7
,, ,, in Trinidad, 7
,, Caravonica, 5
,, ,, and Coco-nuts, 5
,, as Catch Crop for Rubber, 309, 310
,, High Price of Egyptian, 6
,, and Insect Pests, 6
,, Mamara, 5
,, in Mexico, 5
,, Mamara: Value in London, 6
,, not always good with Cacao and Rubber, 7
Cover-Crops (*see* Green Manuring)
Cow-peas, 21
,, as Green Manure, 152
,, ,, ,, for Trinidad, 146
,, Inoculated for Green Manuring, 147

Cow-peas, under Cacao Shade a Failure, 148
Cradwick, Mr. Wm., 7
,, ,, on Grafting Cacao, 274
,, ,, on Sulphate of Iron for Canker, 251
,, ,, on the Woburn Tree-planting Experiments, 307
Crotalaria, 21
,, and *Fomes semitostus*, 144
,, as Green Manure, 142
Crotalaria striata as Green Manure, 158
,, *Sp.* as Green Manure, 157
,, as Green Manure in West Indies, 151
Cultivation of Ceará, The, 417
,, and Fertilization of Cacao, Professor Hendricksen (Cuba) on, 122
Cultivators and Ploughs on Estates, 29
Cupim, The (Brazilian Insect), 433

DA COSTA System of Coagulating in bulk, 44
Dadaps as Green Manure, 142
Davis, Mr. Bertram, on Yields and Cost of Ceará in B.E.A., 446, 448
Dead Wood, Beware of, 226
De Freitas, Hon. D. S. (Grenada), on Tree Destruction, 60
Deforestation affects Cacao, 65, 66
,, and Cacao on the Gold Coast, 65
,, ,, Irrigation, 62
,, in Trinidad (W.I.), 61
,, and Water Supply, 62, 66
Degreasing Waste Products for Plant Food, 166
Dematophora, Is it Root Disease? 213
Derris dalbergioides and Nectria, 204
De Valda, Mr. Frederic, on Castilloa Yields, 371
,, on Funtumia Tapping, 330
Die-back in Bahia, 4, 246
,, combated by Nitrate of Soda, 114
,, in Cacao, Mr. F. A. Stockdale on, 114
,, ,, J. Hinchley Hart on, 114
,, and Thrips, 247
Diplodia cacaoicola, Is it Cacao-pod Disease? 202
Disease diminished by Culture and Care, 247, 248
,, and Pests Cured by Inoculation, 169
Dominica, Benefit of Mulching, 96
,, Cacao Manuring in, 124
,, ,, in: Table of Manuring Results, 125

Dominica and Mulching, 145
Droost, Dr., and Witch-broom Disease, 4, 223
Dumont Coffee Co. and Cost of Labour in Brazil, 327
,, ,, and Rubber (three varieties), 371
Dunleavy, Mr. F. J., on Rubber Tapping in Bolivia, 405
Dutch Islands and Manuring Rubber, 41

ENGINEERS, What the Tropics owe to, 44
Erythrina glauca, 10
Estate Sanitation, 25, 27, 43
"Estrada" tapping, 407, 409
Eucalyptus trees as protective Belts, 51, 52, 53, 54, 55
Eumeces squamosus (a weevil) and Rubber Trees, 347
Eunectria camerunensis on Cacao, 203
Evans, Mr. Frank, 30, 51
,, ,, ,, on "Cacao Improvement by Selection," 292
Extremes in prices of Cacao and Rubber, 26
Exhaustion of Soil? Does Green Manuring cause, 162
,, ,, by Green Manuring: Fertilizers to be added, 163

FAWCETT, B.Sc., F.L.S., &c., Mr. Wm., on Castilloa, 359
Federation Malay States uses *Tephrosia*, 143
Fertilizers, Need of, 182
Ficus elastica in Bolivia, 408
,, *rigo* in Papua, The, 11
,, *vogelii* (Memleku Rubber), 298
Fomes semitostus, 33
,, ,, and *Crotalaria*, 144
,, ,, A Cure for, 344
,, ,, Mr. Gallagher's Views, 341
,, ,, Inoculation a Cure for, 178
,, ,, and *Tephrosia*, 145
,, ,, on West Coast Africa, 229
,, and Tree Stumps, 73
"Forest-devil" Stump Puller, 81
Forking, 19
Fungi and Chlorophyll, 189
,, (parasitic) to control pests, 194
,, the Facultative Parasites, 191, 192
,, the Parasite Family, 191
,, and Pests harboured by Tapping Wound, 312
,, Pests, 189

Fungi in Relation to Agriculture, 189
,, The Saprophyte Family, 191
,, the Serviceable ones, 193
Fungicides and Root Disease, 78
,, Need of Reliable, 182
Fungous Diseases of Cacao, and the Sanitation of Cacao Orchards, by F. A. Stockdale, 246
Fungus foods, vegetable and animal, 191
Funtumia compared to Ceará or Hevea Rubber, 297
,, *v.* Castilloa, regarding pests, 331
,, Figures of Growth, 298
,, and Nitrate of Soda, 35, 41
,, Tapping, 329
,, ,, Mr. A. E. Casse, Hayti, on, 331
,, ,, De Valda's Views, 330
,, ,, with a Gouge (Dr. im Hof's Idea), 329
,, ,, Experiments on the Gold Coast, 332
,, ,, Five Methods Discussed. 333

GALLAGHER, Mr. W. J., M.A., 15, 27
,, ,, on *Fomes semitostus*, 341
,, ,, Lecture on Pará Rubber, 310
,, ,, on Prickers for Tapping Rubber, 311
,, ,, recommends Spraying Machines, 228
,, ,, on Root-disease and its Cure, 209
,, ,, visits Diseased Trees, 171
German Colonies, Funtumia Tapping in the, 329
Gold Coast, Ceará and Castilloa on the, 300
,, ,, Export of Rubber and Cacao from the, 231, 233
,, ,, Experiments with Funtumia Tapping, 332
,, ,, the Evils of Close-planting, 180
,, ,, and grafting Cacao, 271
,, ,, Hevea Rubber on the, 299
,, ,, Large yields of Cacao at the, 237
,, ,, and Plant Diseases, Mr. Tudhope on the, 180
,, ,, The, probably cheapest Cacao-producing Centre, 234, 235
,, ,, Prospects of Hevea, 304
,, ,, Rubber on the, 297
,, ,, ,, Improved methods of Preparing, 305
,, ,, The. Why the Cacao is poor in quality, 236
Grafted Cacao, Canker on, 244
Grafting ,, 264

Grafting Cacao by Approach in Haiti, 278
,, ,, Hart on Criollo, 273
,, ,, Hart's method, 286
,, ,, Hart on Nicaraguan Cacao, 273
,, ,, in Hayti, by Mr. A. E. Casse, 275-283
,, ,, on Gold Coast, 271
,, ,, Imper. Depart. for W. Indies on, 270
,, ,, Nicaraguan on to *Calabacillo*, 292
,, ,, ,, grafted on to *Forastero* or *Calabacillo*, 273
,, or budding Cacao, the question of, 267
,, ,, ,, Preferable to Seed Selection, 268
Grass-root Poison on Estates, 23
Green Manures, 20, 141
,, ,, mixed with Artificials, 140
,, ,, cannot grow under Cacao, 146
,, ,, add Nitrogen and reduce weeding bills, 164
,, ,, (Cover-Crops) v. Clean Weeding, 164
,, ,, The Ideal a Non-climber,
,, ,, and Soil-erosion in Ceylon, 162
,, ,, yield Nitrogen and prevent Erosion, 162
,, ,, for Antigua, names of eleven, 151-159
,, Manuring advocated by Mr. Kelway Bamber. 142
,, ,, Benefits of Inoculation, 148
,, ,, for Ceará, sow by dibbling, 450
,, ,, and fertilizing Bacteria, 160
,, ,, how it improves the Soil, 141
,, ,, improves Hevea Trees, 141
,, ,, in British Guiana, 143
,, ,, Inoculated Cowpeas, 147
,, ,, prevents Soil Erosion, 161
,, ,, results in Ceylon, 161, 162
,, ,, and Surface-feeding Trees, 160
,, ,, Table of results of, 153
,, ,, and the use of Cover Crops, 159
,, ,, and Wide Planting, 449
Grenada, Cacao and Cotton in, 7
,, Cacao Crops in, 105
,, Increased profits by Manuring in, 103
,, and Inoculated Cowpeas as Green Manure, 147
,, Intensive Cultivation in, 102
Guano improves Rubber Trees, 41
Gutta Percha (*Mimopsys excelsa*) in Bolivia, 408

HARRIS, Mr. T. J., on Budding Cacao in Jamaica, 280
Harrison, C.M.G., &c., Professor, 10
Hart, J. Hinchley, on Black Rot in Cacao, 199
,, ,, on "Die-back" in Cacao, 114
,, ,, on Grafting Cacao, 274
,, ,, ,, or Budding Cacao, 284-292
,, ,, on Local Trees for Windbelts, 57
,, ,, on Pruning Cacao, 107
,, ,, on White Ants living on Fungi mycelium, 225
Hartgrink, Mr. G., on Inoculation or Injection, 184
Hawaii and Ceará Rubber, 426, 432
,, ,, Yields, 37
,, suits Ceará, 472
,, and Ceará Manuring, 36
,, ,, Tapping, 36
Hayti, Castilloa Tapping in, 370
,, Funtumia Tapping in, 331
Hendricksen, Professor (Cuba), on Cacao Manuring, 116-127
Hermessen, J. L., on Castilloa in Mexico, 379-404
Hevea benefited by Complete Manures, 42
,, ,, Green Manuring, 141
,, ,, Guano, 41
,, Best Results by Wide Planting, 458
,, in British Guiana, 141
,, Close *v.* Wide Planting. 377
,, compared to Funtumia and Ceará Rubber, 297
,, Liability to Disease on Cleared Cacao Land, 200
,, Trees lost through Wound Fungi, 254
,, Minimum Price for Exporting Fine Hard, 485
,, Net Profit on Wild and Cultivated, 482
,, in Peat Soils, Failure of, 33
,, and Nitrate of Soda, 35, 41
,, Prospects on the Gold Coast, 304
,, on the Gold Coast, 299
,, the Question of Moisture in and Price of Fine Hard, 481
,, Tapping on the Gold Coast, 299-302
,, same family as the *Manihots*, 50
,, same cell-system as the *Manihots*, 373
,, a Typical *hygrophyte*, 32
,, in Zanzibar, 428
Horner's Tillage Implements for Estates, 30
Hosmer, Mr. (Hawaii), 36

Hygiene in Cacao Planting, 97
Hymenochæte in Samoa same as *P. omnivora*, 200
" on West Coast Africa, 229

IDEAL Green Manure a Non-climber, The, 163
Importance of Nitrogen as a Plant Food, The, 108
India, Mr. Proudlock on Rubber in, 308
Indo-China (French) and Tapping Rubber, 327
Inoculated Cow-peas as Green Manure, 147
Inoculation as a Cure against Black Blight, 174
" " for Pests and Disease, 169
" a Cure for *Fomes* and *Termes*, 178
" or Injection, Work by Scott-Elliot, 172
" against Pests, Mr. Rud. Anstead's Views, 174
" " " Mr. Malins-Smith's Views, 174
Insecticides, Need of Reliable, 182
Insect Pests and Cotton, 6
Irpex flavus of Coffee same as *P. omnivora*, 200
Irrigation for Ceará, 468
Isolating Areas on Estates, 7

JACKSON, Mr. T. B. (Antigua), on Green Manuring, 151-159
Jamaica and Budding Cacao: How it is Done, 280
" Cure for Pests in, 46
" Planter uses Basic Slag, 1
" Success of Horse-bean (*Canavalia gladiata*) as green manure, 155
Java, Ceará Tapping in, 443
" *Sporotrichum* in, same as *P. omnivora*, 200
" uses *Tephrosia*, 143
Jequié Rubber Tree, The (*M. dichotoma*), 421
Jones, Mr. Joseph, on Canker on Grafted Cacao, 244
" " on Grafting Cacao, 270
" " on Manuring Cacao in Dominica, 124
Jungle Belts, Danger of, 15

KANTHACK, Mr. F. E., on Trees and Water Supplies, 62
Kew Bulletin on Ceará, 417
Koschny, Herr Th. F., on Castilloa Yields in Costa Rica, 396

LABROY, Professor, on Castilloa and Hevea Tapping, 373
Landolphia Kirkii, An Analysis of, 488
" *owariensis* on the Gold Coast, 305

Lasiodiplodia theobromæ, 16
Lazy Soils and their Cure, 17
"*Lecanium*," or Mango Scale. 174
Lewa Estate and Ceará. 459
"Lewa" System of Tapping, The, 475
Light and Air Check Pests, 183
Lima-Bean (*Phaseolus lunatus*) same as Barbuda Bean. 154
Lime for Cacao Soils, 89, 204
.. Effect on Manures, 90
.. Overdoses of. 19
London School of Tropical Medicine, 43
Lyon-Beans. 21

McCALL, Mr. Stewart, on Ceará in Nyasaland, 449
,, ,, on Nyasaland Rubber, 308
Mahogany as Protective Belts, 51
Magic as a Catch-Crop, 363-380
Malaya, Peat Soils in, 32
,, and Rubber Diseases, 73
,, Rubber Statistics, 337, 340
Malins-Smith, Mr. W. M., on Cacao Grafting and Budding, 264
,, ,, on Canker, 204
,, ,, on Inoculation against Pests, 174
,, ,, on Inoculated Green Manures, 149
,, ,, on Intensive Cultivation in Grenada, 102
,, ,, on Plant-sanitation, 205
Mamara Cotton, 5
,, ,, Value in London, 6
Mango Scale or "Lecanium," 174
Manihots. The New, 421
,, ,, in the Nursery, 425
,, ,, How to Plant them, 423
,, ,, their Respective Heights, 421
,, ,, the Soil they Prefer, 424
,, ,, their Yield, 422
,, same Cell-system as *Hevea*, 373
,, same family as the Hevea, 50
,, the Soil Preferred, 433, 446
,, and Wind, 433
M. dichotoma (Jequié Rubber), 421
,, in Bahia, 246, 470
,, gives a Huge Yield, 444

M. Glaziovii, Derivation of, 419
M. heptaphylla (São Francisco Maniçoba), 421
,, Dr. Ulé's Method of Tapping, 444
M. piauhyensis or *piauiensis* (Piauhy Maniçoba), 421
,, Dr. Ulé's Method of Tapping, 444
Manures for Rubber Trees: Suggestions for Mixtures, 134, 138
,, ,, ,, ,, Mixture with Green Manuring, 140
Manurial Requirements of Rubber Trees, The, 129
,, Systems, Results of three Typical, 95, 96
Manuring Cacao, 87
,, Prevents Thrips, 94
Massaria theicola and Nectria, 204
Meat (waste) its Phosphate and Nitrogen Value, 165
Memleku Rubber (*F. Vogelii*), 298
Metchnikoff, Prof., 186
Mexico, Cotton in, 5
,, Estate Roads in, 16
,, the Question of Close-planting in, 375
Mixed Crops, 11
,, ,, as Protective Belts, 50
,, ,, How to Plant, 43
Miyoshi, Mr. on Fungi, 188
Moisture increases Rubber Yields, How, 141
,, in Rubber: Does it Pay? 481-482
Monkey-jacks for Root-disease, 78
,, ,, for Stump-pulling, 73, 82, 85
"Morning Glory Vine" (*Ipomœa*) and Castilloa Latex, 385
Mozambique Rubber—an Analysis, 488
Mulching Cacao, Advantages of, 124-125
,, benefits Dominica Cacao, 96
,, may benefit Ceará (*M. Glaziovii*), 142
,, in Dominica, 145
,, Mr. Rud. Anstead on, 145
,, to supply Humus for Cacao Lands, 216
Mycelium (of root-fungus) movements, 74
Mysore, Root-disease in, 75

Nectria caffeicola in Java on Cacao, 202
,, (Canker), Stockdale on, 245
,, *striatospora* on Cacao Stems, 202
,, *theobromæ*: Is it Stem Disease? 202

Nectria theobromæ and *T. pentagona*, 245
,, in Trinidad, 4
Nicaragua, Castilloa Tapping in, 392
Nitrate Dressing for Cacao, 87
,, of Soda for "Die-Back," 114
,, ,, Increasing Rubber Yields, 35
,, ,, Increases Ceará Yields, 36
,, ,, Notes on Application of, 112
Nitrogen and Cacao, 87
,, as a Plant Food, The Importance of, 108
Nitrogenous Manures benefit Cacao, 106
,, ,, Notes on, 111
"Nourriture brune" in San Thomé, 4
Noxious Gas Experiments to Exterminate Pests, 239
Nyasaland, Ceará in, 449
,, Ceará Yields in, 462, 463
,, Cotton as Catch-Crop for Rubber, 309, 310
,, Rubber in, 308
,, Tree-planting in, 55
,, West, suits Ceará, 309

OLD Trees killing Newly-planted Ones, 74
Olsson-Seffer on Germinating Ceará Seed, 469
Onderneeming Station (British Guiana) and Cacao, 227
Overshading, Gain in Cacao by Diminishing, 10, 11
,, and Pests, 7
Oxidization of Rubber, Mr. John Parkin on, 387

PAPUA, The *Ficus Rigo* in, 11
Pará Rubber (*see* Hevea)
Parasites (*see* Fungi)
,, and Pruning in Cacao, 183
Parasitic Fungi to Control Pests, 194
Parkin, Mr. John, on Castilloa Yields, 373
,, ,, on the Oxydizing Ferment in Rubber, 387
,, ,, on Protective Belts, 49
Passiflora fœtida (Passion Flower) and Ceará, 450
Peat Soil, Cure for acidity in, 33
,, ,, in the Malay Peninsula, 32
Penicillium glaucum hyphæ, 188
Perak, Big Rubber Yields in, 322
Pests, Biography of Pamphlets by Experts on, 356

Pests, The Colonial Office Committee, 198
,, Controlled by Parasitic Fungi, 194
,, Extermination: Beware of the Cost, 252
,, ,, by Noxious Gas (SO_2), 239
,, ,, how to avoid excessive cost, 252
,, in Jamaicas, Cure for, 46
,, and Disease Cured by Inoculation, 169
,, General, 196
,, and Overshading, 7
,, and Fungi: Results of Tapping Wounds, 312
,, on Estates, What they have cost, 354
,, on West Coast Africa, 229.
Petch, Mr. T., B.A., B.Sc., &c., 16
,, on *Crotalaria* and *Fomes*, 145
Phosphates for Soil Acidity, 343
,, ,, if exhausted by Green Manuring, 163
Phosphoric acid and Cacao, 87
Phytophthora omnivora, 4
,, ,, in Cacao, 199
,, ,, can attack Cacao Pods from the Bark, 203
,, ,, (Black Rot): How to distinguish it, 200
,, ,, Is it Cacao-pod Disease? 202
,, ,, Spraying prevents, 201
Piauhy Maniçoba Tree, The (*M. piauhyensis*, 421
Pigeon Peas (*Cajanus indicus*) as Green Manure, 159, 363
Pink Disease, 16
Plant Foods from Waste Products, 165
,, Sanitation a cure for Stem-canker, 212
Ploughing, 19
,, and Stump-pulling, 80
,, in Travancore, 30
Ploughs after Stump-pulling, Cost of, 80
,, and Cultivators on Estates, 29
Polystictus occidentalis in F.M.S., 172
Potash and Cacao, 87
,, ,, Basic Slag for Cacao in Mountain Lands, 92
,, its function in Plant Physiology, 89
,, for Soil if exhausted by Green Manuring, 163
Potato Rot, 182
Powel, Mr. H., on Ceará in B. E. A., 458
Pratt, Mr. H. C., on Pests, 345
Preparation of Plant Foods from Waste Products, 165

Prickers for Tapping Rubber, Mr. Ridley's Opinion, 328
Progress in Scientific Cultivation since 1908, 1
Protective Belts, 49
,, ,, to avoid Soil Erosion, 58
,, ,, Carruthers on, 57
,, ,, Cedar as, 51
,, ,, Coco-nuts as, 6, 51
,, ,, Cotton and Cacao, 6
,, ,, and Deterioration of Soil, 58
,, ,, Effect of Lack of, 58, 59
,, ,, Eucalyptus Trees as, 51, 52, 53, 54, 55
,, ,, Prof. Harrison on, 57
,, ,, Hart recommends local Trees, 57
,, ,, Mahogany as, 51
,, ,, needed on West Coast Africa, 64
,, ,, Mr. F. A. Stockdale on. 57
Proudlock, Mr. R. L., on Rubber in India, 308
Pruners or Pickers for Cacao: Boussigniac's pattern, 255
Pruning Cacao, 9
,, Cuts and Fungi, 249
,, Cacao Trees compared to Apple Trees, 275
,, Need of care when, 183
,, and Parasites in Cacao, 183
,, ,, White Ants, 225
Prunings, Evils of Unsanitary, 23

RAMBONG (*F. elastica*) attacked by *Termes*, 196
Rape as Green Manure, 158
Rhodesia and Ceara, 470
Ridley, Mr. H. N., M.A., F.R.S., &c., 32
,, Mr., on Prickers for Tapping Rubber, 328
Roads on Estates in Mexico, 16
Rogers, Mr. C. S. (Trinidad) on Deforestation, 61. 64
Root-canker in Cacao. 206
,, and dead Trees, 208
,, Precautions against, 208
Root-disease, Basic slag for, 214
,, caused by stagnant Water, 78
,, cured by burning the Trees, 78
,, discouraged by Fungicides, 78
,, discouraged by Lime, 78
,, forking a Remedy, 215
,, in Hevea: Mr. Gallagher's Warning, 209

Root disease, Root-pruning advisable, 213
,, Stockdale on need of Cultivation, 215
,, Trenching as a Remedy, 77
Root-diseases of cacao, 213
Root-pruning for Root-disease, 213
Rorer, Mr. J. B., M.A. (Trinidad), 4
,, ,, on Cacao Spraying, 201
,, ,, on Disease in Trinidad, 202
,, ,, on Pests and Spraying, 253
Rosellinia disease, 74, 203
Rotary dryers, 45
Rubber, The advantages of improving West African, 184
,, attacked by Black rot (*P. omnivora*), 199
,, and Cacao, Extremes in prices, 26
,, and Cacao, How to plant, 14
,, and Cotton in Nyasaland, 309, 310
,, Diseases, 335
,, in Dutch Islands, 41
,, Estates and Soil Erosion, 161
,, Exports from Gold Coast, 233
,, on the Gold Coast, 297
,, in India, 308
,, in Nyasaland, 308
,, Pests, The need of "a Stitch in Time," 352
,, ,, and Spraying Machines, 353
,, ,, *Xyleborus parvulus* (shot-hole borer), 348
,, Trees and *Acridium* (grasshoppers), 350
,, ,, Advantages of Artificial Manures, 129
,, ,, Effect of Cattle or Farmyard Manure, 139
,, ,, The Functions of Nitrogen, Phosphates, and Potash, 132
,, ,, Manures, Suggestions for Mixtures, 134, 138
,, ,, ,, Suggestion for Mixture with Green Manure, 140
,, ,, The Manurial Requirements of, 129
,, ,, Nitrogen, Potash, Phosphoric Acid for, 136, 137
,, ,, What Manures to use, 132
,, Weevils, *Eumeces squamosus*, or *Astycus lateralis*, 347
,, Yields affected by Moisture and Green Manure, 141
,, ,, improved by Green Manuring, 141
,, ,, and Sunlight, 475

SACK, Dr., 4
Sahara Desert and Deforestation, The, 67

Samoa, *Hymenochæte* in, same as *P. omnivora*, 200
Sandman on White Ants Extermination, 241
San Francisço Maniçoba Tree, The (*M. heptaphylla*), 421
Sanitation on Estates, 25, 27, 43
San Thomé, Cacao Epidemic in, 4
,, and Ceará Rubber, 430
,, need of Basic Slag and Phosphates, 4
,, and *Nourriture brune*, 4
Sapium Rubber and Scale Insects, 58
Scale insects and *Sapium* Rubber, 58
Scott-Elliot's, Mr. G. F., Inoculation, or Injection work on Trees, 172
Seed Selection, Mr. Frank Evan's Views, 264
,, ,, Mr. Malins-Smith's Views, 264
Shading Cacao (*see* Cacao Shade)
Skin and Trimmings, their Value as Plant Food, 166
Siphonia brasiliensis, 407
Smith, Mr. Jared, on Ceará Seeds and Planting in Hawaii, 464
,, ,, on Ceará in Hawaii, 426
,, ,, recommends Cuttings to assure Yields, 443
,, ,, on testing Ceará for Tapping, 435
Soil Acidity, and its Remedies, 830
,, Erosion and Contour Drains, 59
,, ,, ,, Green Manuring, 161
,, ,, ,, ,, ,, in Ceylon, 162
,, ,, ,, in Grenada, Mr. Branch on, 61
,, ,, ,, Protective Belts, 58
,, ,, ,, Rubber Estates, 161
,, ,, on Tea Estates, 161
Society of Arts Journal on Cacao beetle, 263
Solomon Islands and Mamara Cotton, 6
Southern India and Ceará, 455, 461
,, ,, Details of Ceará Tapping, 461, 462
,, ,, and Root Disease, 74
Sporotrichum in Java same as *P. omnivora*, 200
Spraying Cacao, The advantages of, 249
,, ,, Mr. Rorer on, 201
,, Machines, General recommendation of, 228
,, ,, need of, 182
,, ,, needed on Gold Coast, 229
,, ,, for Rubber and Cacao Pests, Mr. Carruthers on, 353
,, as prevention against Black rot (*P. omnivora*), 201
,, and Topping to cure Witch-broom Disease, 218

Stegomyia mosquito, 43
Stem Disease in Cacao, 202
,, Canker, Mr. O. W. Barrett on, 210
,, ,, Mr. Malins-Smith on, 209
,, ,, Plant Sanitation a cure for, 212
,, ,, The use of the Chisel for, 211
,, Disease : What is it? 202
Stockdale, Mr. F. A., 6, 7, 10, 15, 50, 90
,, ,, on Canker, 213
,, ,, on Close-planting, 226
,, ,, on contour drains, 59
,, ,, on "Die-back" in Cacao, 114
,, ,, on Diseases in Trinidad, 202
,, ,, on Green Manuring, 141-143
,, ,, on need of Cultivation for Root Disease, 215
,, ,, on Pigeon Peas as Green Manure, 159
,, ,, on Root Disease, 213
,, ,, on Tapping Wounds, 312
,, ,, his treatise on "Cacao Disease and Sanitation" 246
,, ,, on the Witch-broom Disease, 218
Stump-pulling, 69
,, in Cochin China, 73
,, Cost of, 80
,, Cost of "Monkey-jacks," 83
,, The "Forest-devil," 81
,, methods in U.S.A., 70
,, and Ploughing, 80
,, Speed attained in Iowa, U.S.A., 70
Sulphate of Iron Wash for Canker, 251
Sunlight and Rubber Yields, 473
Surface Feeders (Trees) and Green Manuring, 160
Surinam, The Witch-broom Disease in, 217
Surinam's way of treating Cacao-beetles, 259, 260
Sword Bean, Overlooker or Horse Bean (*Canavalia Gladiata*), as Green Manure, 155
,, Bean a success in Jamaica, 155

TAPPING Accelerated by Water Receptacles, 442
,, Ceará in Hawaii, 36
,, Rubber, 312
,, Big Yield at Perak, 322
,, in Bolivia, 405

Tapping Castilloa and Hevea Bark, 312
.. Continuous *v.* Occasional Tapping, 316
.. in Ceylon compared to Malaya, 322
.. The Farrier's Knife, 316
. in French Indo-China, 327
.. Funtumia (*see* Funtumia)
.. The Gouge, 316
.. the Ideal Instrument still to come, 315
.. during Leafless Periods, 318
.. the "Lewa" System, 475
.. by the "Machadine," 409
.. Punctures *v.* Cuts, 315
.. Castilloa with Prickers, 313
.. Prickers and "Stone" Cells, 311
.. the Question of a Rotary Tapper, 323
.. Mr. Ridley on Prickers, 328
.. and Tree Pests. Go to Brazil to Study, 375
.. in West Indies. Carruthers on. 323, 324
.. Wounds, and Fungi or Pests, 312
Tar for Wounds: How to carry it. 250
.. .. .. and Pests. 226
Tea Estates and Soil Erosion, 161
Tehuantepec, Rubber in the Isthmus of. 379-404
.. The Soils and Rainfall of. 398
.. The Vegetation of the Isthmus of, 401
Tephrosia, the various Kinds, 144
,, in Federated Malay States, 143
,, and *Fomes semitostus*, 144
,, in Java, 143
,, *purpurea* as a Green Manure, 142, 143
,, saves Labour Bills, 144
Termes gestroi, Inoculation a cure for, 178
,, ,, Mr. H. C. Pratt on, 346
,, ,, no longer a help, 196
,, ,, attacks Rambong (*F. elastica*), 196
Termites, *see* White Ants, or *T. gestroi*
T. pentagona grafted on *T. forastero*, 271
,, Manufacturers' Opinions on, 272
,, (Alligator Cacao) and Canker, 244
Thompson, Mr. H. N., on Forests in Nigeria, 64
Thousand-headed Kale as Green Manure, 158
Thrips and Die-back, 247

Thrips discouraged by Manure and Cultivation, 94
Tobago, Cotton and Cacao in, 7
,, ,, ,, Coco-nuts in, 5
Topping and Spraying to Check the Witch-broom Disease, 218
Travancore, Ploughing in, 30
Treatment of Tropical Plants, The, by Messrs. Bult, 177
Tree Borers and Carbon Bisulphide, 238
,, Nourishment, the Need of, 25
,, Stumps and Root Fungus, 73
Trenching *v.* Inoculation to cure Diseases, 170
Trenches for Root Disease, 77
Trinidad, Cacaô and Cotton in, 7
,, Lack of Plant Food, 3
,, and Nectria Disease, 4
,, Need of Sprayers, 4
,, Mr. Rorer on Diseases in, 202
Tropical Medicine and its benefits in the Tropics, 43
Tsetse Flies, 43
Tudhope, Mr. W. T. D., on Plant Diseases on the Gold Coast, 180

ULE, Dr., compares Hevea with the Manihot Rubbers, 424
,, describes Brazilian Sinuous Tapping, 444
,, on Tapping the new Manihots, 444
Uganda, Ceará Tapping at Entebbe, 459
Unsanitary Prunings, Evils of, 23

VACUUM Drying, 45
Van Hall, Dr., 4
,, ,, on the Witch-broom Disease, 217
,, ,, says Witch-broom Disease only dormant, 223
Velvet Beans, 21
Vertical Forking, 19

WASTE Products become valuable Plant Foods, 165
Water supply and Deforestation, 62, 66
Watts, Dr. Francis C.M.G., &c., on Cacao Pests, 101
,, ,, on Grafting Cacao, 271
,, ,, on Manuring Cacao, 124
Weeding bills reduced by Green Manures, 164
West African Rubber, The advantage of improving, 184
,, ,, treatment of Cacao Beetles, 260
,, Coast Africa needs Protective Belts, 64

West Coast Africa, Pests on, 229
,, ,, and White Ants, 223
West Indies, Carruthers on Tapping in, 323, 324
White Ants and Cacao, 225
,, ,, call for careful pruning, 225
,, ,, living on Fungi Mycelium, 225
,, ,, How Herr Sandman would treat them, 241
,, ,, on West Coast of Africa, 223
Wilcox, Mr. E. V. (Hawaii), 35, 36
Wild and Cultivated Rubber, by W. H. Johnson, F.L.S., 478
Wind-belts, *see* Protective Belts
,, in Malaya, Coco-nuts as, 50, 51
Witch-Broom Disease in Surinam, 4, 217
,, ,, Tapping and Spraying a Remedy, 218
,, ,, What it cost Surinam, 220
Woburn Exper. Fruit Farm and Tree Planting, 307
Woolly Pyrol as Green Manure, 157
Wound fungi causes loss of Hevea trees, 254

Xyleborus (shot-hole borer) and Rubber, 348

ZANZIBAR and Ceará Rubber, 428
,, and Hevea Rubber, 428
Zernichow, Mr. F. on Green Manuring, 142
Zomba (Nyasaland) and Ceará yield, 309

MECHANICAL APPLIANCES SECTION.

AGRICULTURAL Boards and Rat Extermination, 539
Atlas Preservative, The advantages of, 530
,, ,, for Ants in Cork-lining, 526
,, ,, Bath, The, 530
,, ,, increases Resistance to Fire, 532
Axes for felling, 597

Bacillus pestis from Rat-fleas, 537
"Barnard's" Cacao Polisher, 589, 590
Begg, Mr. (Assam) on White Ants, 533
Block Rubber, 560
Blocking Machinery for Rubber, 555, 560, 561, 564
Bordeaux Mixture, 504
,, Paste *v.* Bordeaux Mixture, 506

Bordeaux Paste, The Woburn, 506
Bridge & Co., Ltd., Messrs. David, 548, 561
,, ,, Medals, 548
"Burgess" Tapper, The, 594

CABLEWAYS for latex transport, 570, 571
Cacao Pruners, 601, 602
Clift's anti-formica fluid, 511
,, Fluid Insecticide, 510
,, Manurial Insecticide, 510
,, thick fluid for ringing trees, 512
Continuous pipe-lines for Spraying large Areas, 520
Cork-boards: How to attach them, 524, 526
Cork-board Insulation in Germany, 523
,, roofing for the Tropics, 524
Cork-Insulation, 523
,, ,, A Conference suggested, 525
,, lined Buildings clean and fireproof, 524, 526, 527
,, ,, ,, Vermin-proof, 527
Crêpeing machines for rubber, 555, 565
Crichton-Browne, Sir Jas., on Danysz Virus, 540
,, ,, on Rat extermination, 535

"DA COSTA" Coagulator, The, 550
,, ,, Process, The and its advantages, 553
,, ,, ,, suits all rubbers, 554
Deaths from Plague in India, 537
Depth to Plough, 492, 494
Dirty Rubber Cases, What they cost Planters, 544
Disc Plough, 3 Furrows, 501
,, ,, assists soil sanitation, 497
,, ,, in B.E.A., 493
,, ,, and their advantages, 494
,, ,, a remedy against fungous and other diseases, 497
Dr. Danysz and the Rat pest, 538
,, Virus to exterminate Rats, 538, 539
Drying of Cacao, The, 582
,, Machines for Rubber, 555, 562, 563
Dusty or Dirty Rubber Cases, Avoid, 543

E.C. PLOUGH, 501
Experiments *re* Pest extermination, Messrs. Voss and Pickering's, 506

FELLING Axes, 597
Fire Tests with Atlas Preservative, 532
First Ploughing in New Soils, 492
Forks for Trenching, &c., 599
"Fungal" Insecticide, 508

"GORDON" Dryer in Africa and West Indies, The, 584
,, ,, The, its Method of Working, 583
Gouge Tappers, 595

"HAMEL SMITH" Rotary Dryer, 584
,, ,, Dryer and how it Works, The, 586, 587
Hand Spray-Machines, 516
Hoes, 599
House of Lords, The, and Rat extermination, 540
How to Impregnate Timber against Pests, 529
How and Why to Plough, 491
"Huber" Tapping Knife, The, 548
Hydraulic Rubber Blocking Presses, 561

"JEBONG" Tapper, The. 596
Jumbo Gallows Plough, 500

KNAPSACK Spray Machines, 519

LONDON'S Campaign against Rats, 535

MATTOCKS, 601
Mechanical Appliances, 490
Modern Methods for Destroying Insect Pests, 504

PEST Extermination a Profit Insurance, 508
Pests *v.* Ploughs, 490
Pfleiderer "Universal" Washer, The, 569
Pickering's, Mr. Spencer, F.C.S., Investigations *re* Pests, 505
Planters Stubbing their Land in the Straits, 490
Planting Bars, 599
Planting-out Spades, 600
Ploughs and Ploughing, 490
Ploughing, and its effect on Soil-Moisture, 496
,, for Root-fungus and *Fomes*, 491

Power Spray Machines, 519
"Pruning" in Subsoils, 495

QUESTION of Cork Insulation, The, 523

RAT Extermination, 534
Rat-fleas cause Plague, 537
Rat Population of U.K., 535
Rats as Distributors of Plague, 537
,, How they Increase, 538
Research Work at Woburn, 505
Ridging Plough, 501
Robinson's Antiseptic Coagulant, 514
,, Rat Guards, 514
,, White Ant Destroyer, 512
,, Wood Preservative, 513
Rubber and Cacao for the Big Buyers, 545
,, Drying, 558
,, Factories: How to erect and extend them, 567
,, Machinery, 540
,, Machine Rollers, The grooving of, 556
,, "to type," 545

S.A.E. Gallows Plough, 501
Shaw & Co., Ltd., Messrs. Francis, 562, 569
"Shaw" Coagulator, The: How it works, 562, 563
Sheeting Machines for Rubber, 555, 565
Spades, 599
Spray Machines to carry or "run," 112
Subsoils and Ploughing, 491

TAPPING Cups, Glass *v.* Metal, 591, 592, 593
,, Knives and Estate Supplies, 591
Taylor, Mr. J. Darnley on Drying Cacao, Rubber, &c., 575-582
"Tortuguero"—A Cork-lined Fruit Steamer, 527
Trees, Distance apart, number per acre, 602

"UNIVERSAL" Washer and its Advantages, The, 574, 575
,, ,, at Work, The, 571, 572

VACUUM Dryers, the best for Rubber or Cacao, 559
,, Drying for Rubber, Cacao, Coprah, &c., 575

"Veteran" Tapper, The, 594
Voss & Co., Ltd., Messrs. Walter, 506

WAR against Pests, The, 504
Washing Machines for Rubber, 555, 565, 569
Week's "Multi-Spray" Nozzle, 522
,, and Son, Ltd., Messrs. W., 516
,, ,, Awards, 516
,, Spraying Machines, 516
Werner, Pfleiderer & Perkins, Ltd., Messrs., 569-575
White Ants in Assam, Atlas Preservative for, 533
,, ,, attack Tropical Buildings, 528
Why Timber Decays, 529
Woburn Bordeaux Paste, 506
,, Reports, 505

YATES and Co., Ltd., Messrs. John, 594

JOHN BALE, SONS AND DANIELSSON, LTD., GREAT TITCHFIELD STREET, LONDON, W.

WORK ON A NITRATE OF SODA 'OFICINA.'

GANG READY TO ENTER BOILING-TANK TO DISCHARGE REFUSE

For further details see the two following pages.

WOBURN BORDEAUX PASTE. .

PATENT.

Invented by Mr. Spencer Pickering, F.R.S. (of the Woburn Experimental Fruit Farm), and Mr. W. A. Voss, F.C.S.

THE MOST EFFECTIVE FUNGICIDE IN THE WORLD

15 lb. goes as far as 20/24 lbs. of the ordinary Bordeaux or the dry powder substitutes.

Ready for use. *Mixes easily and perfectly with water.*

THE REMEDY FOR FUNGOID DISEASES.

The "CARLTON" Spraying Machine

(AS ILLUSTRATED).

Capacity 13 Gallons.

FOR TREE SPRAYING OR LIME WASHING.

Fitted with Special Pump for pressure up to **200 lbs.**

Finest Selection of Nozzles for all purposes.

"CARLTON" No. 2 SPRAYER.

Container Strongly Built of Oak.

CAPACITY 20 GALLS.

Fitted to Sledge and specially adapted for **rough ground.**

PUMP AND NOZZLES AS ABOVE.

Price, with One Lance - - - **£5 18 6**

With Two Lances and extra Fittings - **£7 10 0**

Poison all Leaf-eating Caterpillars and Insects by spraying with the CARLTON ARSENATE OF LEAD PASTE.

THE KIND THAT STICKS.

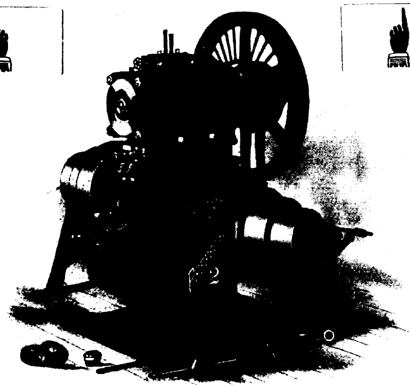
Being actual Manufacturers we are at all times sure of our articles being kept up to their present high standard.

LIVER of SULPHUR & ALL CHEMICALS & SPRAY MATERIALS.

Send for Full List and indent through your usual source.

WALTER VOSS & Co., LTD.,

MILLWALL, LONDON, ENGLAND.



VENESTA, LTD. 20, EASTCHEAP, LONDON, E.C.

VENESTA RUBBER CASES AT COTTON'S WHARF, LONDON.

Mr. KELWAY BAMBER, the leading authority, says:

Do not Ship your . . . RUBBER in rough-sawn Cases.

We say, therefore:

Ship your Rubber in VENESTA CASES.

They are as smooth as planed wood, cost less, and are much stronger.

Being practically, if not actually, air-tight, Venesta Cases turn out the Rubber with the minimum of oxidation. This means **2d. to 6d. lb. better price by using VENESTA CASES.** Shippers of Castilloa, which oxidizes so quickly, should specially note this. Planters, however, who prefer to ventilate the contents of the Cases can have them supplied with small ventilation holes, which do not impair the strength of the cases.

VENESTA CASES of the same Internal Capacity as Wooden Cases, measure **10% to 20% less for Ocean Freight,** and Weigh from **40% to 60% less for Land Carriage,** than Wooden Cases of the same strength and internal measurement. The gain over Rubber shipped in bales or other packages is still larger.

RATE OF FREIGHT ON RUBBER.

RAISED BY HOMEWARD CONFERENCE.

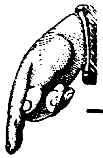
"We are informed that the Homeward Conference of Shipping lines has decided to raise the rate on rubber from F.M.S. ports and Malacca from 60s. to 70s. It is understood that the change will take effect immediately."

Malay Mail, December 28th.

RUBBER FREIGHT.

"It would have been too much to expect the Homeward Conference to refrain very long from putting the screw on the rubber industry. As it is, with rubber at seven shillings a pound, a rise of ten shillings a ton in the freight from Malacca and F.M.S. ports does not at first glance seem at all grievous, especially as shipments from Penang and Singapore are not, for the present at any rate, to be affected; but planters would do well to remember how the conference screwed up the freight on tin from half-a-crown to five shillings a ton during the "boom" and absolutely refused to reduce it by a penny during the "slump."

Penang Gazette.



Tinned Milk in the Tropics.

THE several articles published on the "Handling of Milk in the Tropics," writes "Tropical Life," caused us to receive several letters on the subject, especially with regard to the question of the relative advantages of Tinned *v.* Fresh Milk for tropical use.

In answer to these we consider that there is no doubt that, when made from the best milk in the first place, it is often better to use tinned milk in the Tropics for the following reasons:—

(1) That if a reliable brand of tinned milk is used the tropical consumer is able, whether in the city or away up-country, to obtain as near as possible, the equivalent of fresh milk, put up under hygienic conditions, and kept free from foreign matter.

(2) If put up in "travellers' size" in "one man ration" tins, these can be opened and used at once without risk of the contents becoming contaminated or infected with bacteria, &c., from travelling in the Tropics with open tins of milk.[1]

(3) Being easy of digestion, tinned milk is useful as a food and the handy way these smaller tins for single individuals are put up prevents waste of milk, and reduces one's kit.

(4) Tinned milk is especially suited for estate use and isolated centres, where fresh milk is either unobtainable or extremely doubtful in quality.

(5) Until opened and in use tinned milk cannot be contaminated by porters or milk sellers. (In Egypt a woman was fined for washing or cooling her hands in the milk she was selling.)

(6) It makes good ice-creams for young people, and can be made up in numberless ways as custard, &c., to eat with fruit in the Tropics or elsewhere.[2]

(7) Being reliable in output it is a complete food for babies.

---

[1] See the last Report of the Wellcome Research Laboratory at Khartoum. Messrs. Fussell & Co., Limited, make a speciality of these "one man ration" tins in their "Butterfly" Brand.

[2] Messrs. Fussell have issued a book of recipes of "ice-creams," puddings, &c., where their "Butterfly" brand of milk can be used. This book is well worth applying for from their London Office at 4, Monument Street, E.C.